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proposal

engineering services perimeter industrial road city of hamilton

prepared by



WYLLIE & UFNAL LIMITED
CONSULTING PROFESSIONAL ENGINEERS
TORONTO - OTTAWA - HAMILTON

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WYLLIE & UFNAL LIMITED

J. F. WYLLIE, B.E., P.Eng., M.E.I.C., President

C. S. UFNAL, B.A.Sc., P.Eng., M.E.I.C., Vice-President & Sec.-Treas.

1 Greensboro Drive
Rexdale, Ontario
Telephone: 248-6105

105 Main Street East
Hamilton 20, Ontario
Telephone: 522-0016

156 MacLaren Street
Ottawa K2P 0K 9, Ontario
Telephone: 232-1107

1 Greensboro Drive,
Rexdale, Ontario, M9W 1C8.
June 28th., 1973.

LETTER OF TRANSMITTAL

Mr. W. A. Wheten, P. Eng.,
City Engineer and Manager of Water Works,
Corporation of the City of Hamilton,
City Hall, Hamilton, Ontario.

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Dear Mr. Wheten:

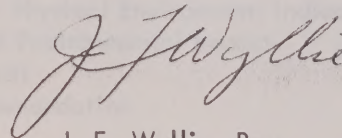
Re: Invitation for Proposals to Study the Perimeter Industrial Road ..
Burlington Street to Highway No. 403.

In accordance with your invitation to submit a proposal for the engineering and related services for the above project, the attached has been prepared.

The two principal firms for this project will be Wyllie & Ufnal Limited and N. D. Lea & Associates Ltd., with the assistance of specialists as delineated in the submission. We are pleased that a transportation firm of the eminence of N. D. Lea & Associates has joined with us for this project.

We would like to thank the City of Hamilton for selecting our firm to submit our qualifications for this important assignment.

Respectfully submitted,



J. F. Wyllie, Pres.

WYLLIE & UFNAL LIMITED

JFW:mf
encls.



CONSULTING ENGINEERS

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PROPOSAL

FOR THE STUDY OF THE

HAMILTON PERIMETER INDUSTRIAL ROAD

PART I

INTRODUCTION

This proposal is respectfully submitted in accordance with the Terms of Reference and its objectives which require - as per our meeting with the Sub-Committee of the P.E.T. - a study to create a truck route to connect the one way couple of Wellington Street and Victoria Avenue via Burlington Street or Strachan Street to Hwy. 403 along the shoreline of or across Hamilton Bay.

The area of detailed study would generally encompass the Hamilton Harbour northerly to the existing C.N.R. trackage between Hwy. 403 and the Wellington and Victoria Streets one way couple.

The areas of general and specialized study are as outlined in the body of this proposal.

This submission, we believe, provides the requested information of structure organization, project development, scheduling, methodology, staff and fee structure for the development of the Study.

A resume of the Consultants in this consortium and their Senior Personnel involved is included in Appendix "A".

PART II

ORGANIZATION AND TEAM APPROACH

The Project Team has been organized by Wyllie & Ufnal Limited, who, as the prime consultant, is responsible for the co-ordination and management of the Study.

The Study will be co-ordinated by a Project Manager who is directly responsible for completion and scheduling of the Study - reporting to the Consultants Committee, who in concert will report to the Sub-Committee of the P.E.T. under the direction of the Consultant's Committee Chairman.

The following Specialist Consultants, in conjunction with Wyllie & Ufnal Limited, form the Project Team.

N. D. Lea & Associates Ltd. as consultants in
Transportation Planning and Economics

Professor N. Shulman and Professor P. Sheriff as
consultants in Public Participation and Social Structure

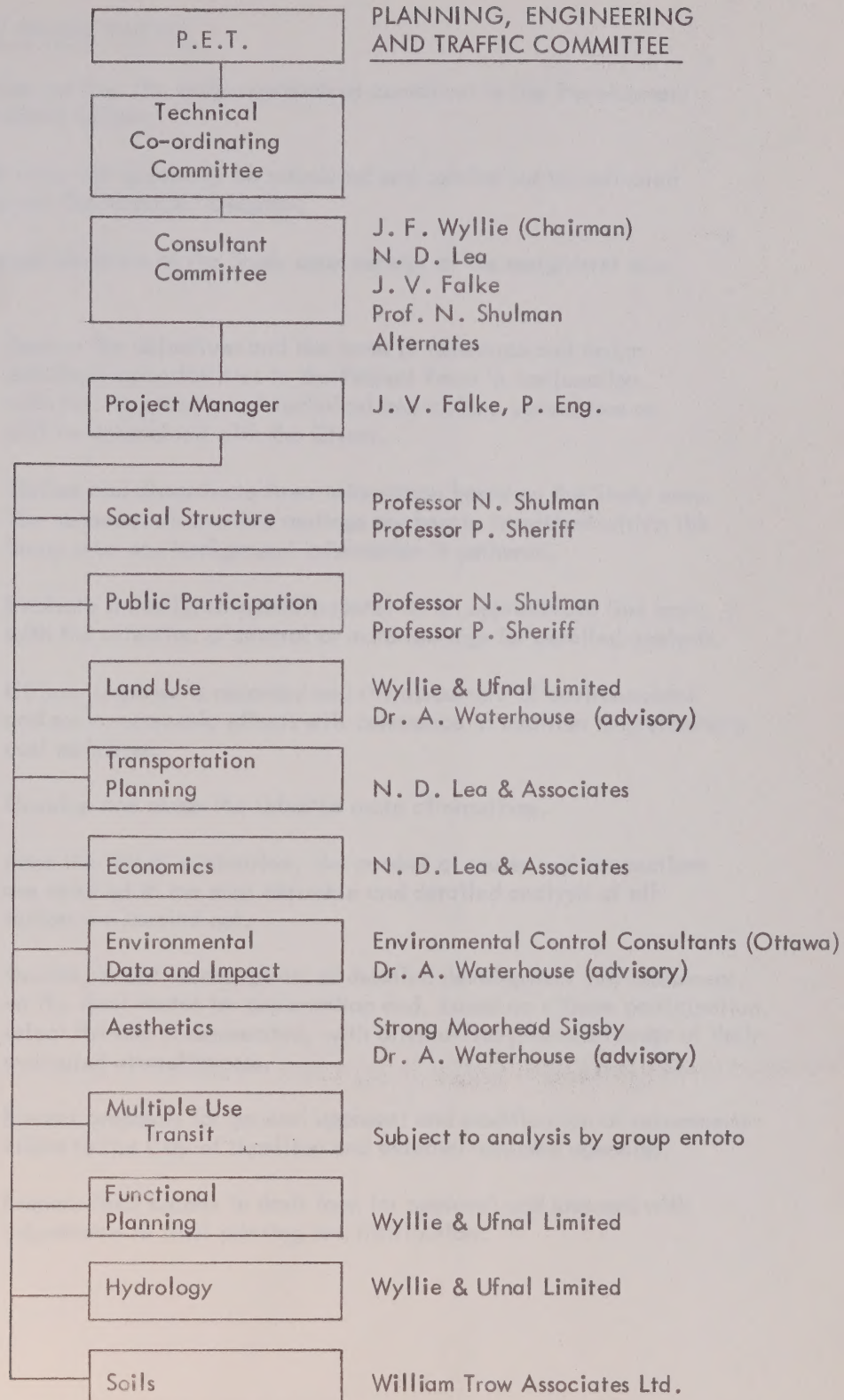
Strong Moorhead Sigsby as consultants in Aesthetics of the
Alternatives

Environmental Control Consultants Ltd. as consultants
in Environmental Data and Impact Studies

In addition, Dr. A. Waterhouse will act in an advisory
capacity in Land Use Planning, Noise and Air Pollution
and Aesthetics as the need arises.

A chart of the Study Organization and our relationships is presented on the following page.

STUDY ORGANIZATION



PART III

PROJECT DEVELOPMENT

This section outlines the study approach as contained in the Development Diagram which follows.

The study tasks will generally be scheduled and carried out as indicated in the Project Development Diagram.

The principal divisions of the Study upon receipt of the assignment are:

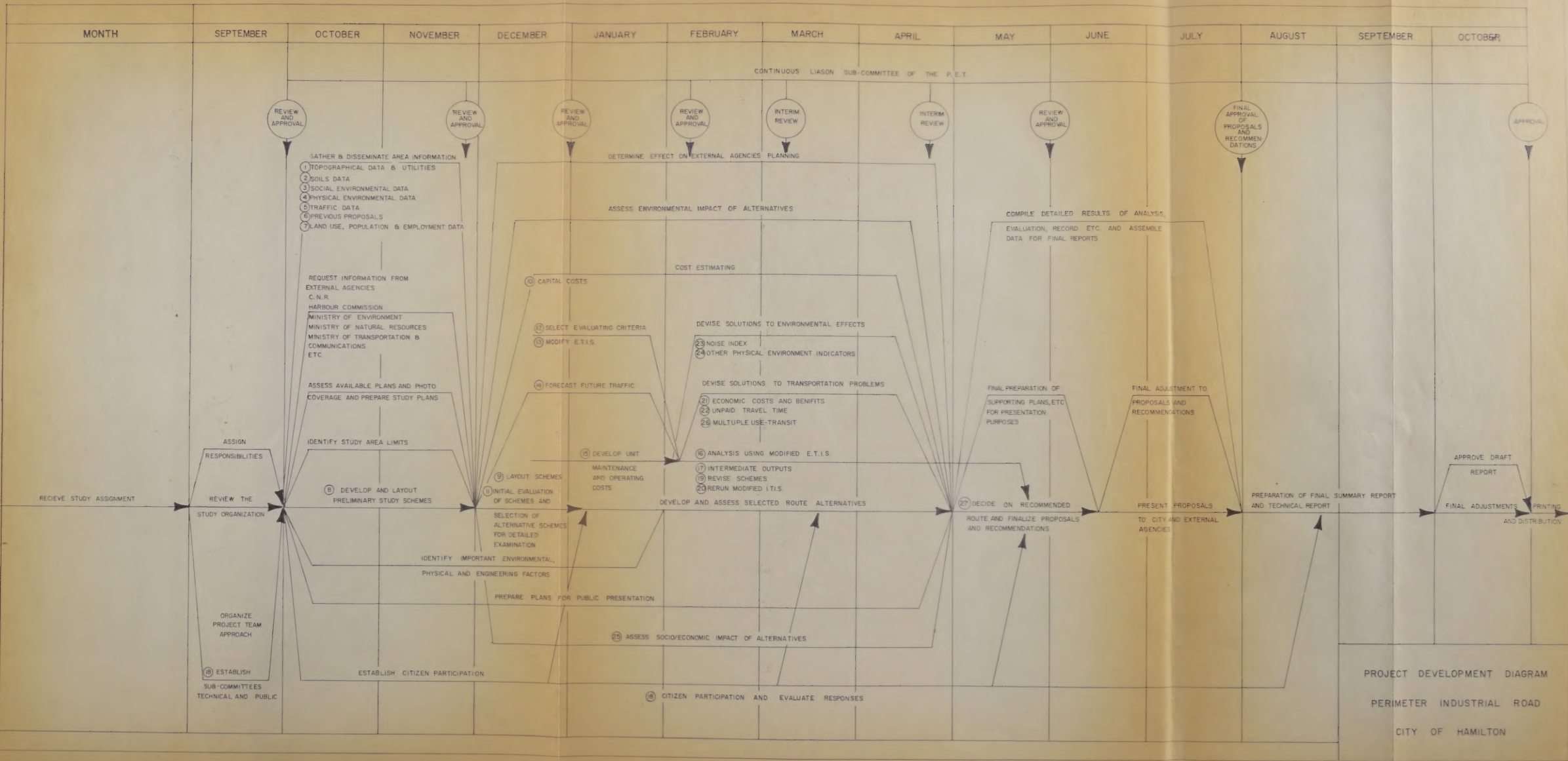
- (a) Review the objectives and the terms of reference and assign detailed responsibilities to the Project Team in conjunction with the organization of technical and citizen committees as will be determined with the Client.
- (b) Gather and disseminate Area information based on the Study area. The numerous alternative routings are herein identified within the Study area and background information is gathered.
- (c) Evaluate initially all possible routes on an approximate line basis with the selection of several or more routings for detailed analysis.

Citizen response is recorded and the assessment of environmental and socio-economic effects will commence in addition to preliminary cost estimates.

- (d) Develop and assess the selected route alternatives.

From the initial evaluation, the number of routes and connections are reduced to the most desirable and detailed analysis of all factors are carried out.

- (e) Decide, based on the results of detailed development and assessment, on the final routes for presentation and, based on citizen participation, select the one recommended, with alternatives placed in order of their evaluated attractiveness.
- (f) Present proposals for general approval and modification of recommendations to the City of Hamilton and external affected agencies.
- (g) Prepare final reports in draft form for approval and proceed with adjustments to final printing and distribution.



PART IV

PROJECT SCHEDULING

An indicated scheduling of this Study is contained on the Project Development Diagram, totalling 14 months, beginning in September 1973 and carried through to October 1974.

It must be recognized that the Development Schedule could expand or contract with time, considering the intangibles in obtaining approvals and depending upon the results of public participation and the reliability of gathered data.

The various tasks of the Study, therefore, may have to be adjusted in accordance with developments during the Study.

In addition, it is assumed that plan coverage and utilities information are readily available and adequate. Should further information be required, delays in obtaining such information could affect the scheduling of the Study.

PART V

PROJECT METHODOLOGY

This section of the Proposal presents the Methodology to be used by the Project Team to achieve the objectives of the Terms of Reference.

Note: The numerical sections hereunder are referenced to the circled numbers on the Project Development Diagram.

1. Topographical and Utilities Data

Existing topographical mapping and aerial photographs are available and will be used in conjunction with existing hydrographic maps from the Ministry of the Environment, along with other data.

For the preliminary route studies, existing mapping available from the City and prepared in 1968 will be used. As the detailed studies unfold, up-to-date detail topographical mapping will be required from the most recent aerial surveys. Past information will be utilized to avoid time gaps.

It is assumed that utilities plans, both general and detailed, will be made available in order that the effects on utilities of alternative schemes may be readily assessed in the costing.

PROJECT METHODOLOGY Continued

2. Soils Evaluation

The soils evaluation for a study of this nature will be a general assessment of the soil conditions along the alignments of proposed alternatives and an examination of any special soils construction methods, which might be needed for particular alignments, especially in respect to the route across Hamilton Bay.

The work will involve four phases:

- (a) A terrain evaluation study of the proposed alignments using aerial photographs. Black and white photography at a scale of 1 inch equals 1000 feet will be used for this purpose, and the evaluation will be tied into geotechnical information from the area.
- (b) Initial soils data gathering from the area both from William Trow Associates Ltd. files and those of the Geological Survey of Canada stored at the Hamilton City Hall. This will provide a general soil stratigraphy along the proposed alignments. However, the information available from the Geological Survey will not be collected in detail during this phase, as this would be a very time consuming activity, and could be unnecessary.
- (c) Extension of the information gathered in Phases (a) and (b) to present a more complete soils profile for the proposed alignments. This will consist of more detailed study of the Geological Survey data and borings, if needed. The amount of work involved in this phase is indeterminate, as it will depend on the locations of the alignments and associated structures. However, to our knowledge, there is insufficient information available along the proposed alignment across Hamilton Bay and therefore borings will be required in this area. The cost of this phase is not included in the overall project, due to the impossibility to provide an accurate estimate. The cost of such work will be carried out in accordance with the Standard Schedule of Fees of William Trow Associates Ltd.
- (d) Engineering analysis and report preparation. This will include provision of soils profiles along the proposed alignments, consultations with other members of the team to tie in the soils reporting with other aspects, and discussions and recommendations about the construction, especially where the geotechnical conditions will result in special methods to be employed. The cost of this phase of the work has been included in the Fee Structure.

PROJECT METHODOLOGY Continued

3. Social Environmental Data

This will be a careful documentation from existing records of what the people-environment is in the zones affected by the proposed schemes. These would both be the zones which are affected through the removal of traffic from them, and the zones which are affected by the addition of roads to them. This activity would involve studying such things as daytime and night-time population densities, the origin of complaints which have been received concerning trucking noise, etc.

This activity is more fully discussed under Section 18.

4. Physical Environmental Data

This activity involves a documentation of the presently existing physical environment.

Field investigations of the areas encompassed in Terms of Reference by the filling in of Hamilton Harbour and the bridging of the Bay respectively, will be carried out early in the project.

A review of existing ecological information and studies will be conducted by a comprehensive literature review and personal interviews with appropriate individuals in the Government, University and private sectors.

After all specialist information has been gathered and documented, analysis of the two alternate routes under consideration will be required. This will need to be done by inter-disciplinary meetings of the Project Team examining different criteria, evaluating conflicting requirements, etc.

The analysis will consist of an impact statement of the effects (both detrimental and beneficial) as a result of the proposed development.

More specifically it would include an analysis of:

- (a) the effect on the indigenous biota of Hamilton Harbour and environs as a result of filling operations and general construction activities;
- (b) the environmental impact on the flora and fauna as a result of operational activities such as increased automotive emissions concentrated in the area;

PART V

PROJECT METHODOLOGY Continued

4. Physical Environmental Data Cont'd.

- (c) noise pollution and its effect on the general neighbourhood;
- (d) air contaminants, type, concentration and natural dispersion and their predicted effect on human health.

A report, prepared by Environmental Control Consultants Ltd., containing all data, analysis and findings will be presented for inclusion either in whole or in part, in the final report to be presented to the client. This report will include the data presented graphically in matrix forms.

Further, aesthetic and visual impact studies will be carried out by the firm of Strong Moorhead Sigsby, in the form of

- (a) Environmental and land feature analysis as a vital part of the route selection and criteria.
- (b) Visual impact analysis - comparative studies of alternate routes as they affect both the road user and those who will be affected by the road.

This work will be done in close co-ordination with all appropriate members of the design team and the Client to formulate the rational for final route selection.

Also, as required, hydrologic studies as to the probable effects of filling in the Bay will be made on water flow and circulation. This work would involve a study of flow patterns based on a review of existing data.

PROJECT METHODOLOGY Continued

5. Traffic Data

Hamilton is in quite a good position as far as raw traffic data is concerned for this project.

Recent modelling work has been done forecasting future vehicular traffic throughout the area based upon forecasts of person/trips. This work will be used as the regional traffic background information against which the effect of the proposed perimeter road will be treated as variations.

The recent truck survey, the information from which has been edited, factored, and stored on tape, will provide exceptionally good information concerning truck movements.

Based upon careful study of the truck O-D survey information and some massaging of this information to get a full appreciation of some possible weaknesses of it for purposes of this project, a highly selective major trucker and shipper interview procedure will be developed and these interviews carried out to aid in the forecasting of future truck travel. For example, there may be some significance to certain truck movements which did not cross a screen line in the O-D survey. There may also be some substantial O-D movements which need to be better understood in so far as the criteria which decide vehicle routing.

6. Previous Proposals

There have been a number of previous proposals developed for a perimeter road, several of which were distributed with the terms of reference. All such proposals will be carefully studied with the reasons which have already been given for and against, being clearly documented.

7. Future Land Use

General descriptions will be required of how the lands affected by the perimeter road are expected to develop in the future, and as to the increase in the pace of activity on lands which generate traffic. It is planned that the description of anticipated future use of the affected lands will be prepared from an appreciation of studies which have already been done, and that the increased activity generating traffic will be taken care of through the selected interviews of truckers and shippers as described under activity 5.

PROJECT METHODOLOGY Continued

7. Future Land Use Cont'd.

The study will examine the population growth of Hamilton and specifically, the Study area. It is planned that forecasts will be prepared from information available from the City Planning Department and the 1971 Bureau of Statistics figures.

From the above mentioned sources, the Study will determine the employment forecast and will provide the required data.

8. Develop Schemes

Making use of the information resulting from and during information gathering activities 1 to 6, the Project Team will develop in quick sketch outline form at a scale probably of 1" = 1000' the various schemes and their variations, which it is considered would be worthy of study during the project. A serious attempt will be made to think up all of the schemes which are at all possible. The total list of schemes will then be reduced in discussion with the client to perhaps six or eight which are worthy of study in the first cycle.

9. Layout Schemes

The six or eight schemes which have been selected in activity 8 will be laid out at a larger scale, perhaps 1" = 200' in preparation for being subjected to more intensive study.

10. Calculate Capital Costs

The schemes which have been laid out in activity 9, will now be costed using rather rough order of magnitude unit costs.

11. Evaluate Geometry

The schemes which have been laid out in activity 9 will be evaluated so far as their geometry is concerned with respect to both capacity and safety. This would be a preliminary evaluation.

12. Select Evaluatory Criteria

In consultation with the client, a selection will be made of those criteria which will be used in the ultimate evaluation and selection of a layout for the perimeter roadway.

PROJECT METHODOLOGY Continued

12. Select Evaluatory Criteria Cont'd.

The costs, namely capital construction cost, vehicle operation cost and road maintenance cost, are the most straight forward criteria. Even in this case, however, there are a number of decisions which must be made such as:

- (a) How will taxes be treated? Will they be considered as a cost or as a benefit?
- (b) How will right-of-way cost be treated? If the road will make accessible some land which is otherwise non-accessible, it could well result in the increase of property values, and some have argued that this is a benefit. On the other hand, there will clearly be financial costs associated with the acquisition of right-of-way. The question, in this case, is whether these should be treated as economic costs or simply as transfer payments.
- (c) There is the value of unpaid time which sometimes is critical. Sensitivity tests carried out on some such projects in the past have shown that the selection, based upon cost criteria, can be drastically changed by a changed value being placed upon unpaid time. It has been the practise of N. D. Lea & Associates Ltd. to divide person-time into two categories, namely, paid time and unpaid time. The paid time category includes the time of truck drivers, bus drivers and the like, all those who are, in fact, being paid while travelling, so that the wages which they are paid enter into the G.N.P. We include this as an economic cost at the average wage rate. Unpaid time is treated separately and quantified separately, and is used as a social indicator expressed in man-hours. Sensitivity tests may then easily be run applying various dollar values to the unpaid time.

As part of activity 12, other social indicators will also be selected, the most important of which is probably a noise index. We propose to borrow from the experience of N. D. Lea & Associates Ltd. with aircraft noise index which is a product of the noise intensity, and the number of people affected. This will require treating differently several periods of the day because it has been shown that residential neighbourhoods are principally affected by night-time noise and commercial neighbourhoods are principally affected by daytime noise.

As far as community character impact, aesthetic impact, impact upon vegetation and wild life, and disruption of community activity, it is possible that some numerical indices may be developed or, alternatively, that verbal descriptions of the impacts of the various schemes may be chosen as the evaluatory criteria.

PROJECT METHODOLOGY

13. Modify ETIS

ETIS is a computer programme which has been developed by N. D. Lea & Associates Ltd. for the purpose of analyzing transport links and printing out the economic and social indicators which are most helpful in evaluating various schemes or alternatives. ETIS is such a recent programme that a detailed description of it is not available, but we attach an Appendix B, a write-up on ERIS which is the predecessor of ETIS. The attached write-up describes ERIS in the form that it was developed for and is being used by the Ottawa-Carleton regional district. The most significant changes which have been made in developing ERIS, and which would be applicable to this project are the following:

- There is provision for optimizing staged construction.
- A table of typical vehicle operating costs can be prepared.
- Unpaid travel time is printed out year-by-year in man-hours as a separate column and may also be quantified in dollars by inputting an hourly rate which may be different from the rate for paid time.
- There is provision for rapid sensitivity testing using control cards.
- Incremental rate-of-return analysis may be done as well as the standard benefit/cost and total transportation cost calculations.

One of the substantial advantages of the ERIS or ETIS programmes on this project is that they analyse the vehicle operating cost separately for each of the several vehicle types. In the case of ETIS, up to nine vehicle types may be used, and for each vehicle type, the operating costs which are calculated take into account the grades, the surface condition of the road and the degree of congestion.

Although the use of this type of link analysis may sound rather complicated, in fact, the N. D. Lea & Associates Ltd. staff who will be used on this project have employed the analysis on several previous projects and have developed a rather rapid operating routine which gives a very great deal of useful detailed information, at modest cost.

For purposes of this project, ETIS would be modified to print out also a noise impact rating for each link and each scheme.

PART V

PROJECT METHODOLOGY

14. Forecast Future Traffic

ETIS requires the input of both present and future traffic on each link. We have available an urban goods computer programme, which is being used for simulating the flows of multiple vehicle types taking into account capacity restraint. Our present belief, however, is that it will not be necessary to this type of traffic simulation for purposes of this project, but rather that it will be practical to analyze the information on the present traffic including the truck survey, to develop growth factors and diversion curves, for the truck traffic, and to interpret the future traffic forecasts which have already been made so as to provide by manual means reasonable estimates for the future traffic on the various schemes. This will, of course, need to be divided into normal and diverted traffic for purposes of economic analyses.

One of the problems in the traffic assignments or diversions will be the treatment of truck regulations. From experience it is known that it is erroneous to assume that trucks will simply obey regulations even though they are clearly posted. The degree of observance depends upon both the level of enforcement and the level of inconvenience imposed. Estimates will be made, in each case, of the extent to which such regulations will be obeyed and the traffic forecasts based upon these estimates rather than upon an assumption of 100% obedience.

Transit will also receive special attention. It is expected, however, that the number of transit vehicles will have no significant effect upon traffic congestion. The relative convenience of the various schemes from the point-of-view of transit service will be considered under activity 26.

15. Develop Unit Maintenance and Operating Costs

Any analysis of vehicle operating and road maintenance costs require the input of a number of significant unit costs. The ETIS programme clearly specifies the form in which the unit costs must be input. N. D. Lea & Associates Ltd. have developed such unit costs for a considerable number of other projects and will be in a position to do so quite rapidly for purposes of this project.

PART V

PROJECT METHODOLOGY

16. Analysis Using Modified ETIS

Once all of the inputs have been prepared as described in activities 9, 10, 11, 14 and 15, all that is required is to code and to keypunch this information, and to run ETIS for each of the proposed schemes. The output will then tabulate in the form shown in Appendix B certain economic and social indicators for each link and for each scheme involving several links. Those social and environmental impacts which are not quantified will need to be described to supplement and make complete the ETIS outputs as tools for evaluating each scheme.

17. Intermediate Outputs

The outputs from the first set of runs of ETIS will be the same in form as those described as outputs from the final runs under activities 21, 22, 23, 24 and 25. The intermediate outputs are different only in regard to the use to which it is intended that they be put. The use of the intermediate outputs is principally for evaluation for interaction with the public, and as a result of this, for modification of the proposals.

18. Public Interaction

This activity consists of analyzing the social structure of the affected area and developing public participation as described in the following:

(a) Social Structure

Our analysis of social structure will include a demographic analysis of those communities affected by the route. This would be developed on the basis of published and unpublished materials from Statistics Canada, and data from several local studies. In this context, we will also identify the significant facilities, organizations and groups in these communities, as well as the boundaries and focal points of the communities.

The other important aspects of this social structure analysis are very closely related to our concerns with public participation, and accordingly are dealt with in a later section (see especially section d).

PROJECT METHODOLOGY

18. Public Interaction - continued

(b) Public Participation

On the basis of information collected in our Social Structure analysis and additional personal contacts, a list of concerned groups within the area will be established (ratepayers groups, ecological groups, groups associated with the Botanical gardens, local agencies, etc.). Key representatives of such groups will be interviewed, or alternatively, group meetings will be held with several interested members, to solicit views on the proposed changes. In addition, interviews will be carried out with aldermen of the area and representatives of industry for the same purpose.

A Working Group of local people particularly interested in the project will be encouraged to develop. This group could be called together at regular intervals as the investigation progresses to review developments in the project and to discuss the various viewpoints expressed.

The Hamilton Office of Wyllie & Ufnal Limited would be used for the purpose of disseminating information to interested persons as well as serving as a center for the collection of information from those in the area.

The purpose of this series of effort would be:

- i - to benefit from the expertise of local people;
- ii - to identify and clarify the issues which relate to this project;
- iii - to bring together the various interested persons and their diverse views and interests in order to bring about a sharing of these views and the resolution of some potential conflicts.

Evidence from other local projects suggests that the provision of adequate information to those potentially affected and the involvement of interested parties can significantly reduce public opposition. The above programme, combined with its educational material discussed in the next section should accomplish the desired results.

18. Public Interaction - continued

(b) - continued

There are, however, a number of "costs" that may result. In addition to the expenditure of time and money, there is also the possibility that the programme outlined above will crystallize opinions and make manifest some latent conflicts. The various opinions gathered may serve to delay progress of the project and the weight of opinion may turn out to favour the existing situation and reject any alternatives. While these are all possible costs, it would seem clear that by proceeding in the manner outlined, we have the best opportunity to determine public feeling and to incorporate public participation.

While it is planned that the initial collection of public views through formal interviews and informal contacts should take about 3 months, the Working Group will continue to operate for the duration of the project and will receive feedback from the survey (to be outlined in the next section) and, prior to the taking of any firm decision, could act as a forum for an airing of community opinion.

- (c) As part of the input of information, a confidential survey will be conducted. The purpose of this survey will be to gather information from a sample of the general public as to their preferences among alternate routes, their aesthetic choices, and their concerns about the proposed changes. Not only would such a survey provide us with a broadly based set of attitudes and preferences, but it would also help to identify any concerns or anxieties on the part of the public. This information would be utilized in developing educational material to be distributed to the public to encourage a more factual assessment of the project.

This general survey would be accomplished by a questionnaire, developed on the basis of a pilot series of interviews, and the opinions collected from the public participation phase of the project. Eight hundred questionnaires would be mailed, along with an explanatory letter, to a representative sample of Hamilton residents who might be affected by any changes. These questionnaires would then be picked up by members of the survey team at a pre-arranged time to ensure maximum response.

PART V

PROJECT METHODOLOGY

18. Public Interaction - continued

(c) - continued

To supplement the data collected by the questionnaires, fifty intensive interviews would then be conducted in those areas most closely affected by the proposal. These interviews would take place with heads of households and would be used to clarify issues raised by the questionnaire responses and to discuss in depth the reactions of closely affected residents.

The Working Group would receive reports on the survey results as work progressed. In this manner, the members of the group would not only be aware of each other's opinions, but also of the general spectrum of opinion of residents.

(d) Concluding phase

Data from the various sources outlined above will be synthesized into a general report of the project. This will include an estimate of the effects of the proposed changes on

- i - the communities directly affected and
- ii - the structure of the large Hamilton system.

In the former case, this will include the effects on (1) housing (the number of persons who would have to be relocated); (2) the immediate environment (noise and air pollution); (3) manipulated space (creation of barriers between residents and facilities). In the latter case, this will include changes in (1) land patterns, (2) transportation lines, (3) recreational facilities and (4) general aesthetic factors.

In addition to these structural aspects, the report will include an assessment of general reactions to the suggested changes as well as an estimate of probable community disruption and benefits.

In sum, then, this programme would (a) gather information from local groups, community leaders and the general public; (b) utilize these data to focus the content of information distributed to the public; (c) provide a vehicle for local leaders and public attitudes to influence the ultimate decisions.

19. Revise Schemes

The result of the public interaction and the review and evaluation of the first set of schemes will be to produce some revisions to these schemes. At the present time, it appears likely that these revisions would be modest because there does not appear to be a great deal of flexibility in possible schemes. It is quite possible, of course, that through public interaction, some suggestions will come forward for completely new schemes, and at this stage a decision will have to be taken by the team and the client together as to which schemes will be subjected to further review. In our basic proposal, provision is made only for one cycle of intermediate outputs with six or eight schemes being evaluated in a quick preliminary fashion, and then for a second cycle of more detailed analysis of four schemes as requested by the terms of reference. It is possible that it may be necessary to go through more than two cycles and more than eight schemes in the first cycle and and four schemes in the last cycle. If this were necessary, it would be an additional cost.

As part of the revision of the schemes, activities 9 - Layout Schemes, 10 - Calculate Capital Cost and 11 - Evaluate Geometry, will be repeated and the layouts done in greater detail, possibly at a scale of 1" = 200' and the capital costs calculated with greater accuracy, this time to approximately plus or minus 20%, which will require a complete table of quantities. If any of the revised schemes will have different traffic, then it will be necessary to do some repeat work on activity 14, Forecast Future Traffic.

20. Rerun Modified ETIS

This is simply a repeat of activity 16, this time with somewhat modified input information.

21. Economic Costs and Benefits

One of the outputs for each scheme and link will be a complete economic evaluation. This evaluation will include the following:

- total transport costs calculated as the present worth of capital maintenance and operating costs discounted at an agreed opportunity cost of capital -- this total transport cost may then be compared with the costs of other schemes and the cost of neutral path or do-nothing scheme. The most attractive scheme selected by this criterion will be the one with the lowest total cost.

PART V

PROJECT METHODOLOGY

21. Economic Costs and Benefits - continued

- the internal rate-of-return will be calculated for each of the schemes and links with this being used for the comparison of schemes with the objective of seeking a high rate-of-return, certainly greater than the opportunity cost of capital.
- benefit/cost ratio--this will also be printed out and can be used in a similar way to the other economic indicators.
- the first year that benefits equal cost. This will be used as an indicator of when the project is economically justified for implementation.
- sensitivity tests will be run for variations in several of the principal input items so that an assessment can be made of the effect on the economic indicators of possible variations in the input information such as, traffic volumes, costs, etc.

22. Unpaid Travel Time

As previously described, the unpaid travel time will be output in man-hours by link and by total scheme. This may be assessed in terms of man-hours or it may be converted into dollars using any cost per man-hour which is considered appropriate. A common procedure here is to do a sensitivity type analysis using several dollar rates for unpaid time. This, of course, can be easily and cheaply done by ETIS.

23. Noise Index

As described under activity 12, it is anticipated that for each link and scheme a noise index will be developed and printed out which will show the relative severity of the noise in each scheme as it affects people. We anticipate that the noise index would correlate in a reasonable way with the number of complaints about noise that would be received from the public.

24. Evaluation of Other Physical Environment Indicators

Indicators of the effect of the various schemes upon wild life and vegetation, community intrusion, etc., will likely be in qualitative terms, which will require a fair amount of description of this physical environmental impact of the various schemes.

PART V

PROJECT METHODOLOGY

25. Evaluation of Social Environmental Impact

Similarly, the evaluation of the effect of the schemes upon the community life will likely require a substantial amount of qualitative description.

26. Multiple Use - Transit

Based upon the forecast traffic for each scheme, estimates will be made of the relative importance and advantage which each affords to transit operations and the results expressed both in terms of the likely actual effect upon the level of transit service and also the variable cost effect for transit to maintain a constant level of service.

27. Selections for Recommendation

It will be necessary, in close co-operation with the client, to give weights to the various evaluatory indicators giving consideration to the preferences expressed by the public. Thereby, a composite indicator will be constructed to suggest the selection of one of the schemes as a recommendation.

28. Reports

As the project progresses, technical memoranda will be produced which will present in detail the findings of each stage of the project. There may be a dozen or more of these technical memoranda, one for example, presenting the background soils information; another describing the various schemes which have been developed and how the eight have been selected for the first cycle of evaluation, etc.

The final report from the project will summarize the most significant of the information from the technical memoranda and will present in some detail, the evaluation of the few schemes which were considered to be the most serious contenders for the selection, and will present completely the arguments for the selection and recommendation of the one scheme. This report will be presented in draft final for review and comment by the client and when these comments have been received and considered, it will be issued in final form.

PART VI

SCHEDULE OF CONSULTANT'S FEES

We and our associates have carefully examined the Terms of Reference and the invitation to submit a proposal and the requirements by the City of Hamilton contained therein.

Therefore, we are prepared to carry out this undertaking in accordance with your dictates and our preceding proposal and delineation of the work involved for the Lump Sum fee of \$157,425.00.

Not included in these charges are the following items which we feel are beyond our control and the amount of and need for which cannot be determined at this time.

Specifically these items are:

1. Photography and special presentation material that may be required for public participation meetings.
2. Soil borings (if required)
3. Purchasing aerial moziac and topographic plotting of latest aerial photography of the area.
4. Special investigations, studies or meetings beyond the City's Terms of Reference as contained in our proposal which may be requested by participating governmental bodies, external agencies or private concerns.
5. Printing of Summary and Final Reports.
6. Interim reports or copies of material where more than 12 are requested.
7. Our Hamilton Office will be treated as the base of operation and cost of travelling and expenses for ourselves and N. D. Lea & Associates are not included in our Lump Sum figure, for trips or meetings which are more than 20 miles radially from the City Hall of Hamilton.

For the above, the charges will be in accordance with the normal A.P.E.O. Consulting Engineering Contract procedure.

We suggest an allowance of \$20,000 be carried to cover Items 1 to 7 above.

INTRODUCTION

The City of Montreal is a large, diverse and an efficient
laboratory for the development of innovative, economic
and sustainable engineering solutions. The municipality has
created for all levels of government and for many other
sectors in the private sector of the economy. Our
municipality has a long and rich history of innovation in the
city of Montreal and its role in the development of the
municipality with a long history of 75, 100 years.

The City of Montreal is a large, diverse and an efficient
laboratory for the development of innovative, economic
and sustainable engineering solutions. The municipality has
created for all levels of government and for many other
sectors in the private sector of the economy. Our
municipality has a long and rich history of innovation in the
city of Montreal and its role in the development of the
municipality with a long history of 75, 100 years.

Approved official use for the following cities:

City of Montreal
City of Quebec
City of Ottawa

APPENDIX A

FIRMS AND SPECIALTY CONSULTANTS

THEIR BACKGROUND, EXPERIENCE AND KEY PERSONNEL

Appendix A, City of Montreal



MEMBER
ASSOCIATION OF
CONSULTING ENGINEERS
OF CANADA

INTRODUCTION

The firm of Wyllie & Ufnal Limited and its affiliated companies provide a broad range of management, planning and consulting engineering services. We have carried out projects for all levels of government and for many organizations in the private segment of the economy. Our assignments have ranged from minor consultations to the comprehensive planning and design of a major Community Development with a planned population of 70,000 people.

The purpose of this resume is to outline the experience of the firm, its organization, staff and objectives, in order to permit prospective clients to evaluate the capabilities of the firm to serve them in the successful planning, development and execution of their programmes.

Regional offices are located in the following cities:

Toronto	1 Greensboro Drive Rexdale, Ontario
Ottawa	156 MacLaren Street Ottawa 4, Ontario
Hamilton	105 Main Street East Hamilton 20, Ontario



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OF CANADA

HISTORY OF THE FIRM

DESCRIPTION OF SERVICES

The firm of Wyllie & Ufnal Limited, incorporated by Ontario Charter in 1966, succeeds Laughlin, Wyllie and Ufnal, Consulting Engineers, which was founded in 1957 when John F. Wyllie and Chester S. Ufnal formed a partnership with the late W. H. M. Laughlin. Prior to this time, the partners had been associated with the consulting engineering field since 1944. The staff, numbering 50, comprises specialists in our field of practice supplemented by experienced technical personnel. The firm has developed steadily since formation into a widening field of operations. Regional offices are located in Toronto, Ottawa and Hamilton.

We are a Canadian-owned firm with corporate or individual membership in the following professional associations:

- Association of Professional Engineers of Ontario
- Association of Consulting Engineers of Canada
- Canadian Good Roads Association
- Ontario Good Roads Association
- Engineering Institute of Canada
- Canadian Institute on Pollution Control
- Town Planning Institute of Canada
- American Concrete Institute
- American Society of Civil Engineers
- American Public Works Association
- Institution of Civil Engineers
- Ontario Association of Architects
- Royal Architectural Institute of Canada
- Specification Writers Association of Canada
- Urban Development Institute
- Institute of Traffic Engineers



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DESCRIPTION OF SERVICES

Town Planning

- * Urban and Regional Planning
- * Design of Municipalities and Subdivisions
- * Official Plans and Land Use Studies
- * Urban Renewal Studies and Designs
- * Public Housing and Institutional Planning
- * Management Services for Human Environmental Developments

Municipal

- * Water Supply and Treatment
- * Sewerage and Sewage Disposal
- * Expressways and Roadwork
- * Traffic and Transportation
- * Conservation Studies

Structural

- * Industrial, Commercial and Institutional
- * Soils and Foundation Works
- * Hydraulic and Marine Structures
- * Tunnels and Subways
- * Bridges and Dams

Industry and Railways

- * Site Developments
- * Manufacturing Plants
- * Railway Engineering and Related Works
- * Mining Structures and Process Plants



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REPRESENTATIVE CLIENTS

Federal

Department of Public Works
Department of External Affairs
Department of Indian Affairs & Northern Development
Central Mortgage and Housing Corporation

Provincial

Ontario Department of Highways
Ontario Department of Economics and Development
Ontario Water Resources Commission
Ontario Housing Corporation

Municipal

Metropolitan Toronto	Town of Whitby
City of Toronto	Town of Arnprior
City of Ottawa	Town of Schreiber
City of Kingston	Borough of Etobicoke
City of Galt	Borough of Scarborough
City of Barrie	Township of Pickering
City of Stratford	Township of Glouster
City of Sudbury	County of Kent

Business & Industrial

Canadian Pacific Railway Co.	Bulk Carriers Limited
Ontario Northland Railway	Canadian Film Industries
National Starch & Chemical Company Limited	Caron Limited
The Kendall Company (Canada) Limited	Consumers Glass Co. Ltd.
Consolidated Denison Mines	Silverwoods Dairies Limited
	Queensway Medical Centre
	Algoma Steel Corporation

Agencies & Institutions

National Capital Commission
National Research Council
University of Toronto
Toronto Board of Education
Canadian Institute of Steel Construction



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LIST OF MAJOR PROJECTS

TOWN PLANNING, TRAFFIC and MUNICIPAL

<u>Project Cost</u>	<u>Description</u>
Not Established	Saltfleet Community Development - A partnership between the Federal and Provincial Governments under the auspices of Ontario Housing Corporation and Central Mortgage and Housing Corporation. Complete planning, municipal engineering and management for a 3500 acre development in the Hamilton area. The first significant programme by government in Canada to develop a complete community. Planned population is 70,000 people.
\$45,000,000 projected cost	Brule Terrace - A unique multiple housing concept, incorporating an entire neighbourhood including schools, parks, commercial and recreational facilities in a single complex in the Borough of Etobicoke. The project provides 2500 housing units and has received Planning Board approval.
\$8,000,000	Federal-Provincial Land Assembly Project - Complete planning and municipal engineering for over 1,000 acres for public housing and community development in the City of Hamilton.
Not Established	Urban Renewal Project for the City of Kingston - 250 acre waterfront renewal scheme between the downtown core and Queen's University. Preservation of historic buildings in one of the earliest Canadian settlements is a significant aspect of this project.
\$25,000,000 projected cost	Lincoln Area, Fredericton, New Brunswick - Master planning for a complete community on 250 acres providing residential, commercial and industrial development.
\$5,000,000 plus	Planning and engineering for subdivisions for private developers.



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LIST OF MAJOR PROJECTS

TOWN PLANNING, TRAFFIC and MUNICIPAL

<u>Project Cost</u>	<u>Description</u>
Not Established	Official Plan and Land Use Study for three former Lakeshore municipalities (Mimico, New Toronto and Long Branch) in the Borough of Etobicoke in Metropolitan Toronto. Co-ordination of use of a $3\frac{1}{2}$ square mile area of intensively used cores.
\$5,000,000	Thistletown Federal-Provincial Land Assembly Project - Complete municipal engineering for 500 acres in the Borough of Etobicoke for Ontario Department of Economics and Development. The first major attempt by Provincial and Federal Governments to develop an integrated public and private housing scheme with major communal facilities.
Not Established	Rural Areas Development Study - A study of Urban Growth in Wentworth County for Hamilton-Wentworth Planning Area Board. An appraisal of area development relating to the overall form of government in the Hamilton Metropolitan region.
\$10,000,000 plus	Urban Housing and Site Planning projects in Ottawa, St. Catharines, London and Sudbury, providing over 800 housing units and institutional buildings.
\$5,000,000 projected cost	Services Feasibility Study for the Redevelopment of Confederation Square in Ottawa, for the National Capital Commission
\$10,000,000 projected cost	Road Needs Study - County of Kent.
\$3,750,000 projected cost	Traffic and Transportation Study - City of Barrie.
\$1,500,000 projected cost	Christian Island Transportation Study.



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LIST OF MAJOR PROJECTS

TOWN PLANNING, TRAFFIC and MUNICIPAL

<u>Project Cost</u>	<u>Description</u>
\$850,000	Peterborough Federal-Provincial Land Assembly Project - Complete municipal engineering for 85 acres of public housing.
\$200,000	Municipal water distribution system, for Township of Pickering, Ontario
\$150,000	Industrial treatment plants for process water and sewage. The Kendall Company (Canada) Limited.
\$200,000	Sewage system and treatment, and watermain extension, for the Village of Chalk River and the Ontario Water Resources Commission.
\$250,000	Storm Trunk Sewer, for Department of Public Works, City of Toronto.
\$150,000	Drainage System for the Animal Research Institute, Greenbelt Farm, for Department of Public Works, Ottawa.
\$100,000	Sewer and watermain extensions, for the Township of Nepean, and the Township of Glouster.
\$1,000,000	Storm and Sanitary Trunk Tunnel Sewer, for the National Capital Commission in the City of Ottawa.
\$2,500,000	South End Storm Sewer, for the City of Stratford.
\$9,500,000 projected cost	Report on Storm and Sanitary Sewer Systems, for the City of Ottawa with staged implementation.
\$5,000,000 plus	Municipal services constructed in connection with road projects - representative work includes 54" watermains, 8' diameter sewers, pumping stations, tunnelling.



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LIST OF MAJOR PROJECTS

BRIDGES and ROADS

<u>Project Cost</u>	<u>Description</u>
\$8,500,000	Macdonald-Cartier Bridge - One of the three Consulting Engineers appointed by the Federal Government for the design of the main spans between Ottawa and Hull. Longest plate girder span in North America.
\$3,000,000	Ottawa approaches to Macdonald-Cartier Bridge involving three bridges and interchanges, for Department of Highways, Ontario.
\$3,000,000	Interchange and grade separations, Coronation Boulevard and Highway 24, for City of Galt.
\$2,500,000	Underpass, bridges and retaining walls, Eglinton Avenue West, for Metropolitan Toronto.
\$1,600,000	Reconstruction of King Edward Avenue and Main Street, for City of Ottawa.
\$1,300,000	Swing Bridge and approaches, Walpole Island, for Department of Indian Affairs and Northern Development.
\$1,100,000	Grand River Bridge - Highway No. 401 at Preston, for Department of Highways, Ontario.
\$1,000,000	Bascule Bridge, Wallaceburg, for the County of Kent.
\$1,000,000	Midland Avenue grade separation and approaches, for Borough of Scarborough.
\$1,000,000	River crossings and grade separation, for City of Stratford (3 projects).



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LIST OF MAJOR PROJECTS

BRIDGES and ROADS

<u>Project Cost</u>	<u>Description</u>
\$1,000,000	The West Mall Road extension and grade separation, for Borough of Etobicoke.
\$1,000,000	Reconstruction on Rexdale Boulevard, Islington Avenue and Kipling Avenue and interchange, for Metropolitan Toronto.
\$ 900,000	Islington-Cordova road reconstruction and grade separations, for Borough of Etobicoke.
\$1,250,000	Jane Street Overpass, for Metropolitan Toronto.
\$ 700,000	Swing Bridge, Tupperville, for the County of Kent.
\$ 600,000	Railway Bridge crossing Kirkland Lake, for Ontario Northland Railway, Kirkland Lake, Ontario.
\$ 500,000	Finch Avenue - Highway 400 overpass, for Department of Highways, Ontario.
\$ 350,000	C.P.R. underpass and approaches, Schreiber, Ontario.
\$6,000,000	Functional planning for Vanier Expressway connecting Hull, Quebec to the Queensway Freeway in Ottawa, for City of Ottawa and Vanier City.
\$1,300,000	High Level Bridge over the Grand River, approach roads and railway grade separation on No. 2 Highway, for Department of Highways, Ontario, in Paris.
\$2,200,000	Reconstruction of The Queensway and grade separation, for Metropolitan Toronto.



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OF CANADA

AWARDS

The firm of Wyllie & Ufnal Limited has recently received a number of awards for projects which have been judged to be outstanding, progressive, and original in concept.

The selections were made on a national level from many submissions from consulting engineering firms, governmental and other agencies across Canada. We, therefore, feel highly honoured in having received these awards.

Finch Avenue

C.P.R. Grade Separation in the
Borough of Scarborough

- National Design Council and the
Department of Industry Award in 1965

Macdonald-Cartier Bridge

Ottawa River, Ottawa-Hull

- National Design Council and the
Department of Industry Award in 1966

Eglinton Avenue

C.P.R. - C.N.R. - Three-Bridge
Grade Separation in Metropolitan Toronto

- Canadian Consulting Engineering Award
in 1968



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OF CANADA

BACKGROUND AND EXPERIENCE

JOHN FRASER WYLLIE, B.E., P. Eng.

Member - Association of Consulting Engineers
Engineering Institute of Canada
Canadian Institute of Pollution Control
American Public Works Association

PRESIDENT

- 1944 Bachelor of Engineering, Nova Scotia Technical College
- 1944-45 Village of Forest Hill:
Assistant Engineer
- Design and supervision of municipal projects
including watermains, sewers, utilities, roads.
- 1945-47 John T. Hepburn Ltd.
Structural Engineer
- Design of buildings and bridges
- 1947-53 Proctor, Redfern & Laughlin:
Project Engineer
- Design and supervision of many varied projects
in the municipal, industrial and structural field.
- 1953-57 Proctor, Redfern & Laughlin:
Associate Partner
- Responsible for design and supervision of
projects - extending experience into executive
and management field.
- 1957 Laughlin, Wyllie & Ufnal:
Partner
- Consulting Engineering in Civil Engineering field.
- 1966 to present Wyllie & Ufnal Limited:
President
- Consulting Engineer in Civil Engineering field.



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BACKGROUND AND EXPERIENCE

CHESTER STANLEY UFNAL, B.A.Sc., P. Eng.

Member - Association of Consulting Engineers
Engineering Institute of Canada
American Concrete Institute
American Society of Civil Engineers

VICE-PRESIDENT and SECRETARY TREASURER

- 1944 Bachelor of Applied Science, University of Toronto.
- 1944 Ward, McKee Engineering Company Ltd.
Design of industrial power plants.
- 1944-53 Proctor, Redfern & Laughlin:
Design and Project Engineer
- Design and supervision of plants and distribution systems for municipal services, industrial process plants, marine works, dams, roads and bridges.
- 1953-57 Proctor, Redfern & Laughlin:
Senior Project Engineer
- Responsible for design and supervision and co-ordination of major bridge, municipal and industrial projects - staff management and administration.
- 1957 Laughlin, Wyllie & Ufnal:
Partner
- Consulting Engineer in Civil Engineering field.
- 1966 to present Wyllie & Ufnal Limited:
Vice President and Secretary Treasurer
- Consulting Engineer in Civil Engineering field.

BACKGROUND AND EXPERIENCE



MEMBER
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OF CANADA

J. V. FALKE, B.A.Sc., P.Eng.

- 1959 University of Toronto
Bachelor of Applied Science
- 1959-60 Lescon Limited, Consulting Engineers
Field Engineer
- In charge of site location and soils investigation for radar complexes and access roads in Ontario, Alberta, and British Columbia
- 1960-66 Laughlin, Wyllie & Ufnal
Resident Engineer
- Construction of road and bridge projects for Metropolitan Toronto and Township of Etobicoke
- Road Design Engineer
- Ontario approach interchange to Macdonald-Cartier Bridge
 - Reconstruction of Highway #69, Sudbury
 - King Edward Avenue and Main Street, Ottawa
 - Reconstruction of Rexdale-Islington-Kipling and Interchange in Metropolitan Toronto
 - High level bridge, C.P.R. Grade Separation and Approach Roads, No. 2 Highway, Paris
- 1966-70 Wyllie & Ufnal Limited
Chief Road Design Engineer
- In charge of planning and design of roads and interchanges. Major projects are -
- Christian Island Transportation Feasibility Study
 - Coronation Boulevard and Highway 24, Galt
 - Eastview Arterial Feasibility Study, Ottawa
 - Saltfleet Community Development Road System
- 1970 to present Projects Manager
- Queen Street Overhead & Holland River Bridge, Town of Newmarket
 - Storm & Sanitary Waste Water Study, City of Stratford
 - Pleasant Park Road Grade Separation Feasibility Study, Ottawa
 - Saltfleet Servicing - Phase I



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OF CANADA

BACKGROUND AND EXPERIENCE

L. L. KRISTOF, B.Sc., Dip. T & R. Pl., M.T.P.I.C.

- 1944 Royal Military College, Budapest, Hungary
Graduated in Engineering.
- 1944-47 Military Service.
- 1947-57 Project Engineer - Chief Engineer.
Design and field supervision of many varied
projects in the heavy industrial and municipal field.
- 1957-63 Department of Highways, Ontario:
Project Supervisor
- Various highway projects, reinforced concrete
structures and highway interchanges.
- 1963-64 University of Toronto
Postgraduate study in Town and Regional Planning.
- 1965 Department of Municipal Affairs:
Community Planner
- Subdivision approval for eight Ontario counties.
- 1965-67 Canadian Mitchell Associates Ltd.
Senior Planner
- Planning and engineering of Bramalea New Town.
- Official plans and zoning by-laws for municipalities.
- 1967-68 Ontario Housing Corporation:
Land Development Manager
- Planning and engineering of all land development
projects under the H.O.M.E. Plan in the
Province of Ontario
- 1968 to present Wyllie & Ufnal Limited:
Senior Planner



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CONSULTING ENGINEERS
OF CANADA

BACKGROUND AND EXPERIENCE

D. C. BATCHELOR, B.Sc., P.Eng.

1954

University of Bristol, England.
Bachelor of Science in Civil Engineering.

1954-57

Foundation Engineering Corporation:
Structural Designer

- Industrial buildings, sewage and water treatment plants.

Proctor, Redfern & Laughlin:

Design Engineer

- Reinforced concrete, steel and foundation design for bridges, steam generating plant, pumphouses and water intakes.

1958-66

Laughlin, Wyllie & Ufnal:

Design Engineer

- Design of structures for Islington Avenue road project for Township of Etobicoke.
- Design of Finch Avenue Overpass for C.P.R. This structure received a design award in the Canadian Design Awards, 1965

Project Engineer

- C.P.R. Railroad Bridge and approaches, Schreiber, Ontario
- Design of Industrial, Commercial and Institutional buildings.
- Multi-storey building analysis.
- Development of precast, prestressed retaining wall.

1966 to
present

Wyllie & Ufnal Limited:

Senior Design Engineer

- Roads, bridges and buildings for Department of Highways, Ontario, Canadian Pacific Railways, Metropolitan Toronto, Boroughs of Etobicoke and Scarborough and other agencies.



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OF CANADA

BACKGROUND AND EXPERIENCE

J. P. FEDORKIW, B.A.Sc., M.S., Ph.D., A.M. ASCE

- | | |
|-----------------|--|
| 1963 | University of Toronto
Bachelor of Applied Science in Civil Engineering |
| 1963-64 | University of Illinois, Urbana Illinois
Master of Science in Civil Engineering |
| 1964-65 | Laughlin Wyllie & Ufnal
Resident Engineer <ul style="list-style-type: none">- Ontario Northland Railway Bridge, Kirkland Lake- Swing Bridge, Tupperville, Ontario |
| 1965-68 | University of Illinois, Urbana, Illinois
Doctor of Philosophy in Civil Engineering |
| 1968-71 | Skidmore, Owings and Merrill, Chicago, Illinois
Senior Structural Engineer |
| 1971 to Present | Wyllie & Ufnal Limited
Structural Engineer <ul style="list-style-type: none">- Structural Design of Reservoirs for City of Ottawa and Saltfleet Township, Ontario- Reconstruction of Brewer Park Pool for City of Ottawa |



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BACKGROUND AND EXPERIENCE

K. N. SMITH, B.A.Sc., M.S., P.Eng., M.E.I.C., M.ASCE- Ph.D.

1959

University of Toronto

Bachelor of Applied Science. Mr. Smith was an honour student standing first in the civil engineering class and receiving seven scholarship awards at the University of Toronto.

Laughlin, Wyllie & Ufnal:

Design Engineer

- Islington Cordova bridges for Township of Etobicoke.
- Martin Grove bridge for Township of Etobicoke.
- 1000' commercial dock for Algoma Steel Corporation.

1961-62

University of Illinois:

Master of Science.

1962-66

Laughlin, Wyllie & Ufnal:

Design Engineer

- First all welded railway bridge for Ontario Northland Railway.
- Eglinton Avenue Grade Separation, road and rail bridges and prestressed retaining wall.
- Churches, schools and other buildings for architects, including analysis of multi-storey structures.

Project Engineer

- Macdonald-Cartier Bridge.
- Bridge structures for approaches to Macdonald-Cartier Bridge.
- Swing bridge over river Sydenham, County Kent.

1966 to
present

Wyllie & Ufnal Limited:

Chief Engineer

- Walpole Island orthotropic swing bridge.
- Study of Dynamic Behaviour of Bridges.
- Saltfleet Community Development.



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OF CANADA

BACKGROUND AND EXPERIENCE

K. J. DeGRACE, B. Eng., P. Eng.

- | | |
|-----------------|---|
| 1964 | Nova Scotia Technical College, Halifax, N.S.
Bachelor of Engineering, Civil |
| 1964-66 | H. G. Acres and Company, Niagara Falls, Ontario
- Engaged in civil and structural design on hydro electric, commercial and industrial projects and a new boiler installation for a paper mill. |
| 1966-67 | Foundation Engineering Corporation, Toronto, Ont.
Structural design engineer on large shopping centre and industrial projects. |
| 1967-71 | Stone and Webster Canada Ltd., Toronto, Ont.
Civil Design Engineer
- Major projects included Extensive Renovation to Montreal Forum, new facilities for an existing distillery and finally a new 40 million dollar distillery |
| 1971 to Present | Wyllie & Ufnal Limited
- Design Engineer on Wallaceburg Bascule Bridge
- Design Engineer on Saltfleet External Services, including design of reservoir, pumping station, storm channel and storm and sanitary sewer. |

N.D. Lea and Associates Ltd. is a specialist firm of transportation engineers, economists and planners. The Company maintains a small permanent key staff, usually 20 to 30 transport specialists. This is expanded as required on particular projects. The Company was formed in 1962 in Vancouver by Messrs. Lea and Andrews. The Company is wholly owned by its principals and associates who have mostly been working together as a team for the past 17 years. The Company has offices in Toronto, Ottawa, Vancouver and Bangkok.

Through a high degree of specialization in the key disciplines of transportation planning, and through key staff with broad experience, N.D. Lea & Associates Ltd. is able to provide a full range of competent professional services from economic appraisal and engineering assessment to complete engineering design and construction supervision.

One of the Company's principal interests and professional activities lies in regional and urban transport planning. The Company has carried out many regional and urban transport studies both in Canada and abroad. In international transportation consulting, the Company has had as clients the Canadian International Development Agency, the International Bank for Reconstruction and Development and governments of Dahomey, Turkey, Thailand and Tanzania. Much of the firm's transport planning work has been multi-modal giving due consideration to commodity and person transport demand, and the facilities and arrangements which influence their routing.

On urban development and redevelopment projects, the Company has consulted to major developers, city engineering and planning departments and retail organizations. The studies have included evaluation of access roads, present and future traffic flows, transit, parking facility requirements and efficiency of urban transport in both social and economic terms.

N.D. Lea & Associates Ltd. have been particularly concerned with the development of suitable analytical and management techniques for transportation planning and have been instrumental in developing INTRAMACS (Integrated Transportation Planning and Management Control System).

MAJOR PROJECTS

TRANSPORTATION ECONOMIC AND PLANNING STUDIES

In responsible charge of about 20 transportation economic studies involving traffic forecasting and evaluation of roads, railroads, pipelines, conveyors, bridges, shipping and marine terminals.

DAHOMAY LAND TRANSPORT STUDY

Principal in charge of comprehensive engineering economic planning study of roads and railways for the Country of Dahomey. U.N.D.P. project with I.B.R.D. as executive agency. Systems analysis employed.

THONBURI-PAK THO HIGHWAY, THAILAND

Principal in charge of feasibility study and design of the 90 km Thonburi-Pak Tho Highway.

AIRPORT

Resident engineer on construction of the Seven Islands Airport, on the North shore of the St. Lawrence River.

METROPOLITAN VANCOUVER HIGHWAYS STUDIES

Member and Provincial Government representative on Vancouver Technical Committee for Metropolitan Highway planning, with responsible charge of a major portion of the technical studies leading to the report "Freeways with Rapid Transit". Subsequently responsible for traffic studies and highway planning on numerous projects in Vancouver district.

BURNABY FREEWAY

In responsible charge of office handling preliminary studies, design and construction supervision of 12 mile major urban freeway, involving extremely difficult soil conditions.

RE-SITING OF AKLAVIK

As project engineer in responsible charge of preliminary engineering on new townsite.

BURLINGTON BEACH SKYWAY

As project engineer in charge of preliminary studies, design and construction supervision of 8,000 ft., 4-lane high level bridge.

BRIDGE PROJECTS

In responsible charge of engineering office handling preliminary studies, design and construction supervision of about 50 highway and railway bridges, many of them with difficult foundations.

TUNNELS

Member of three-man board in responsible charge of joint venture which prepared a feasibility study and preliminary engineering for this 4-lane vehicular tunnel under the Washington Ship Canal in Seattle with extremely difficult foundations.

MARINE TERMINALS

Preliminary and detailed design of several marine terminal structures using flexible bulkheads, relieving platforms and free standing structures in steel, concrete and wood.

SITE INVESTIGATIONS

In responsible charge of approximately 50 site investigations and reports on soil condition and foundation design for industrial and public works projects.



HIGHWAY PLANNING

Planning services for large or small highway projects, including the preparation of traffic demand forecasts on an origin-destination, route, mode and volume basis

Economic analysis of alternative facility designs and the evaluation of pricing and regulatory policies.

HIGHWAY DESIGN AND CONSTRUCTION SUPERVISION

A complete package of technical services is supplied including:

- route location
- topographical and soils analysis
- highway capacity
- geometrical standards selection
- pavement and structures design
- route marking, lighting and signing
- roadside development
- preparation of plans, specifications
- issuing of tenders and supervision of construction
- PERT and critical path scheduling
- management of construction

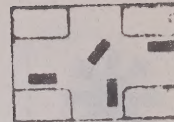
Technical services are provided not only for the highway itself but also for related overpasses, interchanges, bridges, viaducts, grade separations, tunnels

HIGHWAY MANAGEMENT SERVICES

Traffic management analysis leading to improved traffic control and policing requirements.

Pricing, regulation and tax structures studies

Land use, noise pollution effects, social and economic impacts on communities are examined. Photo inventories of road facilities, evaluation of pavement condition and analysis of maintenance and snow removal programmes.



Transportation in the urban area requires adequate street and traffic systems. Our complete service meeting these needs, includes urban traffic modelling, traffic forecasting, economic feasibility analysis, facility design, construction supervision and traffic control.

URBAN TRANSPORTATION PLANNING

- study of land use and urban transportation interaction
- forecasting of person, goods and vehicle transport patterns
- evaluations of competing transportation modes, including automobiles, buses, transit, truck and rail
- analysis of street and other transportation facilities on a capacity, locational, and financial basis
- noise and air pollution analyses
- feasibility taxing and pricing policy studies
- social, economic and land use impact studies

STREET DESIGN

- design of streets and arterial systems
- geometric and structural design of pavements, drainage and structures
- lighting
- preparation of plans and specifications
- supervision of construction

TRAFFIC MANAGEMENT

- control of parking
- intersection signalization
- signing, street marking
- establishment of one way street systems
- truck routes
- accommodation of transit facilities
- computerized traffic signalization, ramp metering
- policing needs studies
- street maintenance and snow removal programs

PARKING

- city wide parking planning
- layout of shopping centre parking and traffic circulation
- design of parking structures
- parking policy and rate structure evaluations



NATIONAL/REGIONAL

DAHOMY LAND TRANSPORTATION

A comprehensive planning study of land transportation for the country of Dahomey in West Africa was executed in 1968 to 1970. This major assignment (\$700,000) was administered by the I.B.R.D. (World Bank) as executing agents for the United Nations Development Programme with N.D. Lea & Associates Ltd. assuming primary technical responsibility in a two-party joint venture. The study included roads, railways, taxation and regulation policies, capital and maintenance budgeting, and feasibility for 800 Km. of roads. Computer techniques were developed for rigorous engineering-economic evaluation of a multi-modal system.

THAILAND TRANSPORTATION

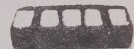
Under the Colombo Plan, with costs shared by Thailand and Canada, a comprehensive transportation evaluation study was carried out, of roads, railways and khlongs in a 4,000 square mile section of Thailand. The objective of the study was to assess the economic feasibility of a proposed highway from Thon Buri to Pak Tho and appraise transport investment priorities for the period 1970 to 1975. The study, in two parts, was conducted in the period 1967 to 1969. The contract was in the Geco name because during this period N.D. Lea & Associates Ltd. was acting as the transportation arm of Geco.

CHURCHILL FALLS ACCESS

A study was made in 1967 for the Government of Canada of the economic impact of a proposed 200 mile road through virgin country from Goose Bay to Churchill Falls in Labrador. This involved evaluation of the effect upon mineral development and forestry exploitation as well as several hydro power projects. The transport options studied were: hovercraft with hoverways, several combinations of aircraft and airports and several standards of roads.

TANZANIA - HIGHWAY PLANNING INFORMATION SYSTEM

N.D. Lea & Associates Ltd. has been retained by the Canadian International Development Agency to conduct an inventory of the complete highway system in Tanzania, using a new photographic technique and to establish a working road inventory data centre to improve the efficiency of road management, maintenance and upgrading.



TRAFFIC DEMAND

Usually our area wide traffic studies measure person travel and modal selection. Future person travel is forecast, split by mode and assigned to route and facility.

PLANNING

The planning of transit systems and their improvement is a crucial activity. It requires first the selection of the most appropriate type of transit:

- rail rapid
- commuter rail
- trolley coach
- bus: freeway, express, standard or mini
- streetcar
- taxis and other demand activated systems
- car pools, jitneys and "drive-yourself" transit

For each type more detailed planning is required. For example, for bus transit, which constitutes, at present, about 70% of the transit in Canada, the following are considered:

- exclusive bus lanes
- exclusive bus streets
- bus stop bays
- special measures, to increase CBD bus flow
- special activation of traffic signals for buses
- route planning and scheduling
- terminal facilities
- bus design
- bus maintenance
- convenience facilities (shelters, etc.)
- fare structure
- communications

It will be observed that a number of the above items require coordination of planning between transit and road planners.

IMPACT STUDIES

The evaluation of actual and proposed transit systems in terms of:

- economic impact
- social impact
- land use impact
- differential impact on various strata of society

URBAN

CANADIAN URBAN TRANSPORT EFFICIENCY

In 1968, N.D. Lea & Associates Ltd. was appointed by the Federal Ministry of Transport and the Central Mortgage and Housing Corporation to evaluate the efficiency of urban transportation throughout Canada and to identify, by means of a broad community systems evaluation, the ways and means to improve this efficiency. The study provides a framework for future evaluations of urban transportation and other aspects of urban life in Canada. In particular, it gives guidance for urban transportation research. A further commission in 1970 by the Federal Ministry of Transport, is to recast the findings into a more convenient form, published in 1971.

NATIONAL URBAN POLICY

In 1970, the firm provided a review of national urban transport policy issues as part of the comprehensive urban policy review by N.H. Lithwick for the Minister Responsible for Housing, Government of Canada.

ELEVEN CANADIAN CITIES

From 1964 to 1966, an extensive study was made of urban transportation in the following Canadian cities: Vancouver, Edmonton, Saskatoon, Winnipeg, Thunder Bay, Kitchener, Hamilton, Toronto, Ottawa, Montreal and Halifax. This study was performed under the sponsorship of the Canadian Good Roads Association and in coordination with a study by the Canadian Federation of Mayors and Municipalities. The results were published in 1966 by the Canadian Good Roads Association in "Urban Transportation Developments in Eleven Canadian Metropolitan Areas".

VANCOUVER

In 1963, N.D. Lea & Associates Ltd. performed work for the City of Vancouver on the Georgia Viaduct requiring a quick updating of the transportation forecasts for the entire downtown area of the City of Vancouver.

From 1965 to date, N.D. Lea & Associates Ltd. has been continuously engaged in a series of studies concerning the planning of transportation for Vancouver. These studies have been for the City of Vancouver, the Province of British Columbia and the federal government. They have involved modelling of the transportation system, forecasting transit and motor vehicle travel, developing and evaluating urban transportation proposals.

N.D. Lea & Associates Ltd. maintains an up-to-date model of the Metropolitan Vancouver transportation system, which has been used recently for both transit and highway evaluations.

BURNABY, BRITISH COLUMBIA

In 1956, Mr. Lea and Mr. Andrews prepared an extensive report on east-west traffic routes through Burnaby and Coquitlam, which required an investigation of existing facilities, forecasts of population, land use and traffic, and the developing and testing of transportation system. As a result of this they supervised the preparation of plans, specifications and the actual widening of the Louheed Highway through Burnaby to expressway standards. They also directed the detailed planning, engineering and construction of the 20 million dollar Burnaby Freeway. This work was done while Lea and Andrews were in the employ of Fenco.

N.D. Lea & Associates Ltd., in 1968 to 1970, carried out, for the Corporation of the District of Burnaby, a comprehensive transportation planning study for this urban municipality of 130,000 people. The planning included traffic, highways, streets and public transit.

WEST AND NORTH VANCOUVER

The Trans-Canada Highway through North Vancouver and West Vancouver has been completely planned and designed by N.D. Lea & Associates Ltd. It is the major arterial through these communities, which have a total population of about 60,000. In performing the preliminary design for this road, methods were developed for the evaluation of travel in smaller communities. These methods have been computerized and applied to other regions as well as the North Shore communities in Vancouver. They greatly reduce the time and cost involved in doing comprehensive regional transportation studies for smaller communities.

KAMLOOPS

N.D. Lea & Associates Ltd., in 1965, completed a study for the Minister of Highways in British Columbia, applying similar regional transportation study methods to the City of Kamloops region of 25,000 people.

NANAIMO

N.D. Lea & Associates completed in 1966, a joint study for the British Columbia Department of Highways and the City of Nanaimo, of the traffic forecasts and future route determination for the Nanaimo area.

METROPOLITAN TORONTO AND REGION

The Company was retained in 1966 by the Metropolitan Toronto and Region Transportation Study to provide staff assistance for the analysis of future travel demands and to plan future transportation systems in the Toronto region for the years 1980 and 2000.

BURRARD INLET CROSSING

In 1965 and 1966, the firm carried out, for the Provincial Government, a comprehensive study of the need for new crossings of Burrard Inlet in British Columbia. This required a comprehensive traffic study of the region's transportation system and detailed economic evaluations of many competing proposals varying in capital cost from \$30,000,000 to \$150,000,000.

From 1968 to 1970, the firm continued with detailed traffic planning of the new crossing and its connections under federal government financing.

CORRIDORS

TURKEY-IRAQ CORRIDOR

A comprehensive investigation of the transportation of bulk commodities, particularly petroleum, in the corridor between the Mediterranean Sea and the Persian Gulf was carried out in 1969 by N.D. Lea & Associates Ltd. for the Government of Turkey.

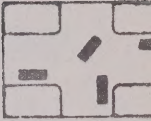
Traffic forecasts based on consumption and production data and consideration of alternative routes through the Suez Canal and around the Cape of Good Hope were made on all competitive modes including railway, marine, pipeline and combinations of these. An engineering-economic evaluation of new transportation facilities and operational procedures such as unit trains was made in this corridor and attractive projects were recommended for detailed feasibility studies.

MAINE CORRIDOR

The firm evaluated, in 1970, for the Ministry of Transport, the feasibility, costs and benefits of various schemes for improving highway facilities connecting Montreal to the Maritimes through Maine. This was done in association with a firm of economists.

TRANSPORTATION CORRIDORS

An evaluation was made, in 1968 and 1969, for the Central Mortgage and Housing Corporation, of the feasibility of reserving land in advance of urban development, so that it might be available when required for future transportation needs. This involved a thorough review of existing land use and probable developments in urban form, detailed investigation of the various existing and foreseeable transportation systems, studies of the economic impact and of possible methods of implementation.



GUILDFORD GARDEN CITY, SURREY, B.C.

A traffic, access and parking analysis was carried out in 1964 for Grosvenor Laing, (B.C.) Limited, concerning the street and highway system required to serve their proposed commercial and residential development in Surrey, British Columbia, which is designed to accommodate 50,000 people.

A further assignment was received in 1967 to conduct studies and report on actual operation of key intersections.

CORPORATION OF THE DISTRICT OF BURNABY

Several studies with recommendations for the construction of roads and parking areas over peat and soft soil areas were carried out in 1963 and 1964.

A further assignment received from Burnaby in 1964 involved a traffic and location analysis for a three-mile major street connection between the Burnaby Freeway and Marine Drive.

A further assignment received in 1967 to design and supervise the construction of the Willingdon-Alpha Connection.

UNIVERSITY OF BRITISH COLUMBIA

N.D. Lea & Associates were retained as Traffic consultants to the University to advise the Traffic Department and to develop long-term traffic and transportation plans. This assignment was carried out in 1963.

CORPORATION OF THE TOWNSHIP OF RICHMOND

Retained by the municipality to prepare recommendations for traffic signal control of access to the new major shopping centre off No. 3 Road. This assignment was carried out in 1964.

A second assignment in 1966 required the analysis of channelisation and signal requirements on Granville Avenue - an adjacent major arterial street.

A further study was carried out in 1966 for the preliminary design of Garden City Road - a six-lane arterial street.

Retained again in 1967 and in 1968 to prepare plans and specifications for traffic signals at several locations in the municipality and to review the feasibility of changing the residential speed limit.

FIRST NARROWS TRAFFIC OPERATIONS

Retained in 1966 by the B.C. Highways Department to study alternative methods of ameliorating the traffic problems at the First Narrows in Vancouver until such time as a new crossing is built. The study encompassed methods of increasing public transit use, and of instituting park and ride operation, traffic surveillance and metering and of making the existing bridge one way only during peak periods.

CANADIAN NATIONAL RAILWAYS

Retained in 1967 by the Canadian National Railways to design and supervise construction of streets and lanes and to report on the storm and sanitary drainage changes required in connection with the new C.N. Tunnel and associated rail line in Burnaby, B.C.

MARINE DRIVE, CITY OF NORTH VANCOUVER

Retained in 1967 by the City of North Vancouver to analyze traffic problems and to prepare functional design plans and operational control systems for this major arterial street. Special emphasis was given to the effects of the completion of the Capilano Mall Shopping Centre and the proposed additional crossing of Burrard Inlet in the vicinity of First Narrows.

TOLLS ON BROCKTON POINT CROSSING

Retained in 1967 by the National Harbours Board to prepare estimates of traffic volumes and toll rates and revenues for several possible conditions and sizes of crossings of Burrard Inlet.

RICHMOND MAJOR STREET PLAN, B.C.

Retained in 1968 by the British Columbia Highways Department to develop a major street plan for the Municipality of the District of Richmond with particular reference to routes connecting to proposed crossings of the Fraser River.

FALSE CREEK DEVELOPMENT, VANCOUVER, B.C.

Retained in 1968 by the developer to study traffic and access to the proposed development.

Continued * *

N.D. Lea & Associates Ltd. maintains a permanent professional staff who are highly experienced in transport planning and design. These include:

Principals: who are the senior shareholders of the firm and the individuals carrying the senior professional responsibility. On each project, one principal is appointed as the responsible principal-in-charge.

Associates are junior shareholders in the firm. All principals and associates must give full time to the practice of their profession through the firm. Usually there will be an associate in charge of a regional office, or as project manager on a major project.

Special Consultants: There are a number of individuals who are on a retainer to the firm as special consultants. Each of these is eminently qualified in a particular field. They may have a university chair or operate from an N.D. Lea & Associates Ltd. office. Their services are provided through N.D. Lea & Associates Ltd. on either an exclusive or a semi-exclusive basis.

Senior Professional Staff: The firm maintains senior professional staff in the following disciplines:

- Airport Planning & Design
- Aviation analysis
- Construction Management
- Engineering of wharves, docks & marine works
- Highway Design
- Highway Planning
- Soils and Materials Engineering
- Structural Engineering
- Traffic Engineering
- Transit Planning
- Transport Economics
- Transport Model Building

The following are the curriculum vitae of the Principals and Associates only.

NORMAN D. LEA

- Born — Canada 1923
Languages — English
Education — B.A.Sc. 1945 Toronto,
Civil Engineering Honours
— S.M. 1950, Harvard, Soil Mechanics
& Foundations
Professional
Organizations — Registered Professional Engineer in B.C.,
Alta., Sask., Man., Ont., P.Q., N.S.,
Washington
— Member A.S.C.E., E.I.C., A.S.A., B.C. Res. Concl.,
Int. Soc. for Soil Mech. & Fdn. Eng.

POSITIONS HELD

- 1945-46 Construction Engineer, McNamara Construction Co. Ltd. supervising construction of buildings and wharves in Newfoundland.
1946-47 Construction Engineer, Foundation Company of Canada Limited. Supervising industrial building in Toronto.
1948-49 Design Engineer, Foundation Company of Canada Limited. Designing buildings and wharves.
1950-53 Senior Soils Engineer, Foundation Company of Canada Limited. Responsible charge of technical staff of 5 to 30 exploring and analyzing foundation conditions.
1954-61 Vice-President, Foundation of Canada Engineering Corporation Limited. Participated in organizing Fenco and Geocon, serving also as Vice-President of Geocon. Established Fenco Vancouver office and remained in responsible charge for six years with staff of 30 to 80.
1962- Senior Principal, N.D. Lea & Associates Ltd.

TECHNICAL PUBLICATIONS (Partial List)

- 1959 "Freeways — Urban Transportation", June 1969 issue of Public Works in Canada.
1959 "The Deas Island Tunnel", August 1959 issue of The Military Engineer
1963 "Highways Over Peat", U.S. H.R.B. (Joint)
1963 "The Hour of Destiny for Engineering", November 1963 issue of Civil Engineering.
1964 "Organizing to Overcome Technical Obsolescence", October 1964 issue of Canadian Consulting Engineer.
1966 "Optimum Rate of Investment in Urban Roads", C.G.R.A. Annual Convention
1966 "Population, Prosperity and Transportation", (Joint), Canadian Transportation Forum, Annual Meeting.
1966 "Urban Transportation Development in 11 Canadian Metropolitan Areas", (Joint), Published by C.G.R.A.

MAJOR PROJECTS

TRANSPORTATION ECONOMIC AND PLANNING STUDIES

In responsible charge of about 20 transportation economic studies involving traffic forecasting and evaluation of roads, railroads, pipelines, conveyors, bridges, shipping and marine terminals.

LARRY D. NIELSEN

Born — Denmark, 1943
Languages — English, Danish
Education — B.A.Sc., Waterloo 1968 — Civil Engineering
Professional
Organizations — Registered Professional Engineer, Ontario
— Member of I.T.E.

POSITIONS HELD

1963-1968 Engineering student, De Leuw, Cather and Company of Canada Ltd.
1968-1970 Transportation Engineer, De Leuw, Cather and Company of Canada Ltd.
1970-1972 Transportation Engineer, M.M. Dillon Limited.
1972- Transport Engineer, N. D. Lea & Associates Ltd.

MAJOR PROJECTS

TORONTO INTERNATIONAL AIRPORT

Project Engineer in charge of conducting ground travel surveys at Toronto International Airport; and subsequent Transportation Study to assess the ground transportation needs of alternative airport sites in the Toronto Region for the Department of Transport, Canada.

URBAN TRANSPORT PLANNING

Transport Engineer on the following comprehensive urban transport studies:

- St. John's, Newfoundland
- Sault Ste. Marie, Ontario
- Asuncion, Paraguay

TRANSPORT SIMULATION MODELS

Systems Engineer developing and testing of S/360 traffic programmes.
Traffic model development for Quebec City and a city in Africa.

HIGHWAY FEASIBILITY STUDIES

Project Engineer for Highway 417 Route Evaluation, Ottawa, Ontario.
Project Engineer for Communications Road Feasibility, Chatham, Ontario.

ROAD NEEDS STUDIES

Project Engineer for Ontario Highways Department Road Needs Studies for:
— Maidstone Township, Windsor, Ontario
— Valley East Township, Sudbury, Ontario

HIGHWAY AND TUNNEL FUNCTIONAL PLANNING

Project Engineer for Highway 3 Tunnel Functional Planning, Port Colborne, Ontario.
Functional planning for the Queen Elizabeth Way from Hamilton to St. Catharines, Ontario.
Traffic analysis for East-West Freeway, Hamilton, Ontario.

HIGHWAY DESIGN

Alignment design Queen Elizabeth Way and Highway 27, Ontario.
Drainage design Weston Road and Highway 401, and Islington Avenue and 401, Ontario.
Estimating quantities and field surveying on various highway projects in Ontario.

JAIME E. CACERES

Born Chile, 1943, Landed Canadian Immigrant

Languages English, Spanish

Education B.A.Sc. Santiago, Chile 1968
M.A.Sc. Toronto 1972 - Transportation

Professional Organizations Registered Professional Engineer

POSITIONS HELD

1967-69 Assistant Engineer, Servicio de Cooperacion Tecnica, Santiago, Chile

1969-70 Civil Engineer, Servicio de Cooperacion Tecnica, Santiago, Chile

1971-72 Supervisor, Transport Safety Project, Civil Engineering Department, University of Toronto

1972- Traffic Engineer, N. D. Lea & Associates Ltd.

MAJOR PROJECTS

ROAD SAFETY STUDIES, TORONTO

Supervised a study of accidents at unsignalized street intersections in Toronto, Canada. The purpose of this study, which was carried out for the Canadian Federal Ministry of Transport was to identify accident prone locations using the General Motors Conflicts Method.

BUS TRANSPORT

In charge of a major study of bus services linking Lima, Peru, and LaPaz, Bolivia to Santiago, Chile, and to services in the southern region of Chile. These services covered over 4,000 Km. of routes. The work included the conduct of passenger origin-destination surveys, forecasting future demand and analyses of costs, tariffs, schedules, profit margins and the effects of railroad and airline competition.

STREET CAPACITY STUDIES

Engaged in a study of intersection capacities in Toronto, Canada. Particular attention was given to the measurement of vehicle headways and traffic flows.

HANS KUEHN

JAIME E. CACERES

MAJOR PROJECTS (continued)

HALIFAX TRANSPORTATION STUDY

Traffic engineer on urban traffic and transit project.

PANAMA TRANSPORT SURVEY

Traffic engineer responsible for traffic surveys, data reduction and highway inventory.

PROFESSIONAL PUBLICATIONS

1977 "Model Shift Procedures for a New Transportation Mode" - TRB, Trans.

MAJOR PROJECTS

- Transportation Studies for the Town of Zurich
- Design and construction studies for an urban road in Zurich-Kloten, Zurich
- Traffic Surveys and Proficiency, Zurich, Switzerland
- Transportation Study, Singapore, Switzerland
- Collection of a traffic volume data base
- Road and street network, traffic and road plans for the Greater City Metropolitan Area, following observation and survey

HANS KUEHNI

- Born — in Switzerland, in 1942.
Languages — English, French, German.
Education — Dipl. C.E. 1968, Federal Institute of Technology, Zurich.
— M.Sc., Transportation, Ecole Polytechnique, Montreal, 1972.

POSITIONS HELD

- 1969-1970 Transport Engineer, Seiler, Neiderhauser, Zurich.
1972- Transport Engineer, N. D. Lea & Associates Ltd.

TECHNICAL PUBLICATIONS

- 1972 *"Modal Split Predictions for a New Transportation Mode"* — M.Sc. Thesis.

MAJOR PROJECTS

- Transportation Studies for the Town of Zurich.
- Design and feasibility studies for an access ramp in Zumikon-Kuesnacht, Zurich.
- Traffic Survey and Prediction, Aegerisee, Switzerland.
- Transportation Study, Murgenthal, Switzerland.
- Calibration of a transport model for Berne.
- Review of transit, parking, traffic and road plans for the Quebec City Metropolitan Area, including simulation modelling.

RENATO MENDEL SCHULTZ

Born Chile, 1941 (landed Canadian Immigrant)

Languages Spanish, English

Education Licenciante in Economic Science, Chile, 1965
M.S., London School of Economics, 1969

POSITIONS HELD

1965-68 Transportation Economist, Chile - California
Programme of Technical Co-operation

1969-72 Senior Transportation Economist and subsequently Head of Market and Demand Analysis, Government of Ontario, Department of Transportation and Communications

1972- Transport Economist, N. D. Lea & Associates Ltd.

TECHNICAL PUBLICATIONS

1965 "Passenger Transportation in Northern Chile", Thesis in faculty of Economics, University of Chile

1969 "Freight Transport in Great Britain and the Transport Act 1968", London School of Economics

MAJOR PROJECTS

PANAMA TRANSPORT STUDY 1972-73

Assistant Project Director on national study developing multi-modal transport policies and investment programmes in a national prospective.

ROADS AND REGIONAL TRANSPORTATION

Evaluation of the regional transportation network and its impact on regional development for the Chiloé and Aysén Provinces in Chile.

Member of a team developing a regional transportation planning framework for Chile.

Member of a team that prepared the transportation budget and national transportation plan for Chile.

RENATO MENDEL SCHULTZ (continued)

MAJOR PROJECTS (continued)

RAIL TRANSPORT

Prepared report aimed at defining the Ontario Government's position with respect to the rationalization of CN and CPR's transcontinental trains.

Appraisal aimed at assessing the effect of the discontinuance and abandonment of the Northern Railway Network in Chile.

An in-depth study to identify the natural resource and market base of the Ontario Northland Railway.

A report on the effects of the proposed run-through in Brockville of the CNR.

Report on the application by Canadian National and Canadian Pacific Railways to discontinue passenger-train services in the Bruce Peninsula, Ontario.

Appraisal of the effects and alternatives to the proposed Nakina, Ontario run-through by Canadian National Railways.

MARINE TRANSPORT

Study aimed at analyzing the operation and economic performance of the St. Lawrence Seaway, at assessing the proposed increase in tolls, and at identifying the relationship between the operation of the Seaway and the ports policy followed by the Government of Canada.

AIR TRANSPORT

Project Manager of a study aimed at identifying the need for airport facilities in Ontario, and recommending a policy for the Ontario Government to follow in the provision of such facilities.

Member of a team studying the long term requirements for Ontario of commercial air carrier services, airports, navigational aids, etc., and their inter-connection with other modes of transportation.

Reported and appraised the application by Transair Ltd. to extend their services to Windsor, Ontario, and recommended the position of the Ontario Government.

Assessed the desirability of extending the runways at Buttonville Airport.

Report on an application by Bohman Airways to the ATC to ammend their license.

RENATO MENDEL SCHULTZ

MAJOR PROJECTS (continued)

AIR TRANSPORT

Member of a team studying the demand for third level air carrier service in Ontario.

Reports aimed at advising on the desirability of granting loans to air carriers for plant, fleet and/or service expansions.

Directed a project to assess the future market potentials for the STOL Demonstration Project of the Government of Ontario.

Report aimed at recommending a regional air services and carriers policy to the Government of Ontario.

1958-1959 Economic Analyst, Transportation Staff, U.S. Air Force

1959-1960 Economist, Vol. 1, Southern & Eastern States
Urban Planning Commission, Chicago

1961 Economist, John D. White Ltd.
Land Use Planning Commission, Toronto

1962-1964 Principal Planner,
Metropolitan Toronto Planning Board

1964-1967 Co-ordinator of Land Use Studies,
Metropolitan Toronto and Region Transportation Board

1967-1969 Chief Economist, Economic Development Dept.,
Ottawa, P.E.I.

1969-1971 Technical Assistance Advisor, Office of
Technical Cooperation, United Nations, New York

1971-1972 Economic Consultant, Government of Ontario
Toronto

1971 - Consulting Economist on staff of
R. H. Lee & Associates Ltd., Oakville, Ont.

W. B. GANONG

Born Canada, 1929

Languages English

Education B.A. (Honours) 1953 University of New Brunswick
Economics

S.M. 1960 University of Chicago
Economic Geography

Diploma in Town & Regional Planning
1961, University of Toronto

POSITIONS HELD

1953-1956 Administrative Officer, Government of Canada,
Ottawa

1958-1959 Economic Analyst, Montgomery Ward & Co., Chicago

1959-1960 Economist, Wm. S. Lawrence & Associates,
Urban Planning Consultants, Chicago

1962 Economist , John W. Combs Ltd.,
Land Economics Consultant, Toronto

1963-1964 Principal Planner,
Metropolitan Toronto Planning Board

1964-1967 Co-ordinator of Land Use Studies,
Metropolitan Toronto and Region Transportation Study

1967-1969 Chief Economist, Economic Improvement Corp.,
Charlottetown, P.E.I.

1969-1971 Technical Assistance Advisor, Office of
Technical Cooperation, United Nations, New York

1971-1972 Economic Consultant, Government of Ontario
Toronto

1973 - Consulting Economist on staff of
N. D. Lea & Associates Ltd., Oakville, Ont.

2.

MAJOR PROJECTS

REGIONAL PLANNING STUDY, EAST PAKISTAN

As Research and Programming Officer, and Acting Project Manager, responsible for study design of a regional planning project in East Pakistan, sponsored by the United Nations Office of Technical Cooperation. The aim of the project was development of an urban and rural settlement strategy for East Pakistan, having regard particularly to the regional resource base, topographical constraints and sector plans for agriculture, transportation, industry and water and power development.

ECONOMIC AND SOCIAL DEVELOPMENT PLANNING, PRINCE EDWARD ISLAND

As Chief Economist of the P.E.I. Economic Improvement Corporation responsible for evaluating development potential and preparing overall economic targets for a joint federal and provincial development plan, and for preparing sector plans for transportation, industry and natural resource development.

Was also responsible for provincial input to transportation policy recommendations by the Atlantic Provinces to the Federal Government, for provincial representation on federal/provincial and/or interprovincial committees on industrial feasibility studies, economic statistics, and petroleum and minerals development, and for direction of consultants undertaking studies of:

1. the economic impact of tourism
2. the tax revenue potential of the province

METROPOLITAN AREA TRANSPORTATION PLANNING, TORONTO

As a member of a small team, participated in a study of Metropolitan Toronto and region, involving a regional traffic prediction model for medium-term planning; a series of alternative long-range land use models and transportation and public finance policy studies.

As program and liaison officer, was responsible for coordinating a study involving collection of data on land use; design of a series of alternative models of socio-economic and physical development of the Toronto region for 15 and 30 year planning horizons; and designing and maintaining critical path schedules of all components of the study. Responsible for preparation of forecasts of economic variables, i.e., regional income, automobile ownership, etc, for traffic forecasting purpose.

3.

OTHER ECONOMIC IMPACT AND LAND DEVELOPMENT PROJECTS

Undertook: economic base studies of four urban areas in Illinois and Indiana, as part of comprehensive plans preparation; studies of population and labour force composition and distribution in Toronto and Ottawa; a study of the impact of improved transportation facilities upon property values (Toronto); preparation of planning guidelines for the location of apartment developments (Toronto); and a study of growth characteristics of the central core (Toronto).

Prepared economic feasibility studies for two shopping centre expansions in Toronto, and tourism projects in California and Florida; participated in development of marketing strategies and site selection for a department store expansion program in several metropolitan areas in the United States.

ENVIRONMENTAL AND ENERGY STUDIES

Undertook research on Ontario's long-range energy supply and demand prospects for the Advisory Committee on Energy of the Government of Ontario, and participated in a task force review of the environmental impact of a mineral development project for the Ontario Ministry of the Environment.

Strong Moorhead Sigsby Limited

2000-2001
Landscape Planning

Strong Moorhead Sigsby Limited has been an active participant in the development of the
Regional Planning in the area since 1987 and has been a major contributor to the
Through the development of the area, the company has been a major contributor to the
in innovation and innovative management of the area, and has been a major contributor to the
development of the area.

In the current the first two years of the project, the company has been a major contributor to the
project and has been a major contributor to the project.

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project and has been a major contributor to the project.

Strong Moorhead Sigsby Limited has been an active participant in the development of the
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Strong Moorhead Sigsby Limited has been an active participant in the development of the
area since 1987 and has been a major contributor to the project.

Strong Moorhead Sigsby

landscape architects and resource planners

Strong Moorhead Sigsby Limited has been an active participant in the development of the
area since 1987 and has been a major contributor to the project.

Strong Moorhead Sigsby Limited has been an active participant in the development of the
area since 1987 and has been a major contributor to the project.

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area since 1987 and has been a major contributor to the project.

Strong Moorhead Sigsby Limited

Landscape Architecture
Resource Planning

Strong Moorhead Sigsby Limited has carried on a practice in Landscape Architecture and Resource Planning in Toronto since 1961 with involvement in a variety of complex projects. Throughout this period the firm has maintained and continually developed its basic expertise in innovative and sensitive understanding of the natural environment related to proposed development.

In this capacity the firm has often associated with firms of other disciplines to provide groups with the best skills available for a given project.

The firm has been actively involved, particularly in the last three years, on evaluating and providing the specific environmental input into highway alignment studies and increased capacity highway studies. Representative projects are listed as follows:

- . Niagara Escarpment Scenic Drive--Feasibility study for the Tri-County Committee - as Parkway Planners.
- . Ontario Highway 403 Alignment Studies (Toronto) for De Leuw, Cather & Company of Canada Limited.
- . Ontario Highway 2 Improvement Studies (Pickering) for Giffels and Associates Limited.
- . Ontario Highway 417 Alignment Studies (Pembroke) for De Leuw, Cather & Company of Canada Limited.
- . Ontario Highway 53 Improvement Studies (Hamilton) for Department of Transportation and Communications.
- . Ontario Highway 400 (Barrie Bypass) for De Leuw, Cather & Company of Canada Limited.
- . Ontario Highway 26 Alignment Studies (Barrie to Stayner) - aesthetic and visual evaluation for De Leuw Cather & Company of Canada Limited
- . Ontario Highway 69 Alignment Studies (Sudbury) for Giffels and Associates Limited.
- . Trans Canada Highway - Recreation Corridor Evaluation within Lake Superior Provincial Park - Ontario Department of Natural Resources
- . Niagara Parkway as part of a comprehensive study for the Niagara Parks Commission.

Personnel whom we would anticipate assigning to the project:

1999

MLA - Harvard University

American Society of Landscape Architects

University of Toronto

—

MLA - University of Michigan

American Society of Landscape Architects

10

BLA - University of Toronto

Canadian Society of Landscape Architects

PROFESSIONAL STAFF

The proposed environmental services will be provided by Mr. W. J. Thurlow and Dr. V. D. Vladykov. Mr. Thurlow has had extensive experience in resource inventories and environmental impact assessment while Dr. V. D. Vladykov, limnologist, has had extensive world-wide experience on aquatic ecosystems. Backup support, as required will be provided by Mr. A. M. Hall who has had experience in environmental studies throughout Ontario and the North.

COMPANY EXPERIENCE

Environmental Control Consultants Limited has operated singly on projects oriented towards Resource Inventories and in consortium on those projects, similar to this study, that require data collection and analysis within an interdisciplinary framework. Such studies have included "A Planning Study for Pukaskwa National Park" (done in consortium with N. D. Lea and Associates Ltd.) and environmental impact studies of a proposed Urban Development for Rattray Marsh; and highway route locations in Banff National Park and Trinidad.

Material on these projects (with the exception of the Trinidad Study) and the "Curricula Vitae" of the personnel to be assigned to this project have been supplied under separate cover.

Mr. Thurlow is currently attached by the Federal Ministry of the Environment as a specialist advising on ecological problems as they relate to the policy and decision making process. He has been involved in this capacity for the last nine months and was a participant at the ecological workshop convened by that Ministry last spring.

Mr. Thurlow is president of the Ottawa-Rideau Chapter of the National and Provincial Parks Association of Canada, secretary-treasurer of the Canadian Society of Wildlife and Fishery Biologists, an executive member of Pollution Probe Ottawa, and a member of the Canadian Society of Zoologists, the Quebec Society of Canada, the Canadian Wildlife Federation, the American Wildlife League, the Ontario Wildlife Council Association, the Wildlife Society, and the Assembly of the Biologists of Ontario.

WILLIAM JOHN THURLOW

President

William Thurlow was born in May, 1935 in Edmonton. He graduated with a B.Sc. in 1960 from Carleton University, Ottawa, and continued postgraduate studies at McGill University, Montreal from 1961 to 1963, writing a thesis dealing with the teratology of various drugs on mammalian fetal development.

Professional History

- | | |
|--------------|--|
| 1969 to date | Thurlow & Associates, Environmental Control Consultants Ltd., president and chairman of the board of directors and specialist consultant on biological applications to environmental problems. |
| 1967 - 1969 | Renewable Resources Consulting Services Ltd., founding president and director. |
| 1964 - 1967 | Canadian Wildlife Service, Department of Indian Affairs and Northern Development, wildlife biologist and supervisor of the technical services section. |
| 1962 - 1964 | Ross High School, Montreal, chairman of the science department and teacher in biology and chemistry. |
| | Sir George Williams University, Montreal, lecturer and senior demonstrator in zoology. |

While employed by the Canadian Wildlife Service, Mr. Thurlow undertook an evaluation of migratory bird sanctuaries in Alberta and Saskatchewan. Since founding Thurlow & Associates, he has been project leader in solid waste disposal studies, and various ecological impact studies. Additional surveys in which he has participated, include a maritime sport fish inventory, a recreation study for the Canadian Council of Resource Ministers and various pollution and limnological studies.

Mr. Thurlow is currently retained by the Federal Ministry of the Environment as consultant advising on ecological problems as they relate to the policy and decision making process. He has been involved in this capacity for the last nine months and was rapporteur at the ecological workshop convened by that Ministry last spring.

Mr. Thurlow is president of the Ottawa-Hull Chapter of the National and Provincial Parks Association of Canada, secretary-treasurer of the Canadian Society of Wildlife and Fishery Biologists, an executive member of Pollution Probe Ottawa, and a member of the Canadian Society of Zoologists, the Genetics Society of Canada, the Canadian Nature Federation, the Algonquin Wildlands League, the Ontario Air Pollution Control Association, The Wildlife Society, and the Assembly of the Institute of Ecology.

Dr. Vadim D. Vladykov

limnologist

Dr. Vadim Vladykov was born in Kharkov, Russia on 18th March 1898, studying at that University, and received his "Doctor Rerum Naturalium" (Ph.D.) from the Charles University in Prague in Zoology and Anthropology in 1925.

Professional history:

- | | |
|-----------|---|
| 1972- | Associate of Environmental Control Consultants Ltd. |
| 1958-1972 | Professor of Biology at the University of Ottawa except for one year during which he was the resident fishery expert in Iran responsible for fisheries management in the Caspian Sea, for the F.A.O. |
| 1952-1957 | Professor of Ichthyology at L'Université de Montreal. |
| 1937-1952 | Director of the Biological Laboratory, Department of Fisheries, Quebec. |
| 1930-1935 | Fishery Biologist in the Maritimes under The Biological Board of Canada. |
| 1929-1930 | Studies in Bacteriology and Serology at L'Institute Pasteur in Paris; in Bacteriology and Phytopathology in Versailles; and Ichthyological investigations for the Museum National d'Histoire Naturelle. |
| 1927-1929 | Fishery investigations in Subcarpathia and Director of the Ethnographical Museum and President of the Society of Aquarists of Subcarpathia. |

Dr. Vladykov is a member of several scientific societies in Canada, North America and Europe and is credited with more than 170 publications.

Thurlow & Associates Ottawa 232-4885 (613)

Alexander MacLennan Hall

wildlife biologist

Alex Hall was born in Brampton, Ontario on December 17, 1942. He received a B.Sc. from The University of Western Ontario, London in 1964 and an M.Sc. from the University of Toronto in 1971. His Master's thesis dealt with the ecology of beaver and the selection of prey by wolves in central Ontario.

Professional history:

- 1972- Thurlow & Associates, Environmental Control Consultants Ltd., consultant on wildlife biology and its application to environmental problems.
- 1971-1972 Employed by Ontario Ministry of Natural Resources during the winter of 1971-72 to write pamphlets on wildlife for public distribution.
- 1970-1971 Arctic studies involving production of muskoxen of the Thelon River, Northwest Territories, and aerial surveys of caribou and snow goose populations in central and northern Baffin Island, Northwest Territories.
- 1966 Conducted a preliminary study of behavioural interrelationships between wild female white-tailed deer and their fawns and participated in a study of the summer distribution, density, and food habits of wolves in Algonquin Park, Ontario.

William Trow
Associates



(Hamilton) Ltd.

**William Trow
Associates**



(Hamilton) Ltd.

William Trow Associates



(Hamilton) Ltd.

William Trow Associates Limited was established in 1957 to provide a geotechnical consulting service to industry and government. The field of endeavour covers all phases of soil mechanics and geotechnical processes. Branch offices throughout Ontario provide a rapid and accurate appraisal of local problems.

In 1967, Construction Testing Services Limited was formed by William Trow Associates to provide a technical and consulting service in other phases of materials testing.

A resume of C. D. Thompson, who will co-ordinate the gathering of and interpretation of soils information is included with some of the projects on which the Trow Group has been involved as a soil mechanics or material testing consultant.

RESUME



NAME: Christopher David Thompson

AGE: 35

EDUCATION: University of Cambridge, B.A. 1959
University of Cambridge, M.A. Civil Engineering, 1963
University of Western Ontario, M.Sc. 1965

MEMBERSHIP: Association of Professional Engineers of Ontario
Engineering Institute of Canada
American Society of Civil Engineers

LANGUAGES SPOKEN: English

EXPERIENCE: 1959 - 1962 with De Leuw, Cather Co. Ltd. of Canada in Ottawa, Ontario, in design and construction of highways, bridges and sewers.

1964 - 1968 with the Department of Public Works of Canada, initially as a soils project engineer, then as principal authority in soil mechanics for the Department. Work included foundation design, and foundation construction control on a wide range of civil engineering projects, including wharves, breakwaters, roadways, buildings, sewers, etc.

1968 - Present, General Manager and Vice President of William Trow Associates (Hamilton) Ltd. Responsible for similar design and construction as during the period with the Department of Public Works of Canada.

Typical Projects

BRIDGES

St. Joseph's Island Bridge, Sault Ste. Marie
Sheppard Avenue over Don River
Willows Bridge over Highland Creek, Lawrence Avenue East
Leaside Bridge over Don Valley
Walpole Island Bridge over St. Clair River, near Wallaceburg
Drinkwater Street Bridge, Sudbury
Markstay Bridge

HARBOURS

North Sidney Harbour – Nova Scotia
Canso Harbour – Nova Scotia
Kingston Harbour – Jamaica
Lakehead Terminal – Ft. William, Ontario
Ship Street Wharf – Hamilton, Ontario
Ship Channel and Turning Basin – Toronto, Ontario
Wharf Reconstruction and Harbour Improvements –
Parry Sound, Collingwood, Cobourg, Whitby, Ontario

C U R R I C U L U M V I T A E

Name: Norm Shulman
Address: 133 Herkimer, Apt. 904
Hamilton, Ontario
Phone: 525-9450
Born: July 3, 1942, Toronto, Canada
Marital Status: Single

Education:

Bloor Collegiate Institute: Honours Diploma, 1962
University of Toronto, B.A. (psychology), 1965
Carleton University, M.A. (sociology), 1967
(Thesis: "Mutual Aid and Neighbourhood Groups")
University of Toronto, Ph.D., June 1972
(Thesis: "Urban Social Networks")

Research:

Research Associate	Canadian Research Centre for Anthropology, 1966.
Research Consultant	Ontario Confederation of University Faculty Associations, 1968-70.
Principal Investigator	East York Network Study, 1969-70.
Principal Investigator	Migrant Relocation Study, 1973 - under contract to Ministry of State for Urban Affairs.

Publications:

"Mutual Aid and Neighbouring Patterns: The Lower Town Study",
Anthropologica, vol. 9, no. 2 (1967)
with F.G. Vallee, "The Viability of French Groupings outside Quebec", in Mason Wade (Editor), Regionalism in the Canadian Community 1867-1967, University of Toronto Press. (1969)

(continued)

Publications: (continued)

with C.M.T. Hanly, Who Pays: University Financing in Ontario,
James Lewis & Samuel. (1970)

Teaching:

Sessional Lecturer

Carleton University, Summer, 1968.

Assistant Professor

Department of Sociology
McMaster University, 1970 -

Visiting Lecturer
(Summer Programme)

University College
Durham University
Durham, England, Summer 1972.

Consulting and Evaluating:

Ontario Confederation of University Faculty Association

Canada Council

Ministry of State for Urban Affairs

Ontario Habitat Foundation

References:

Dr. William Michelson
Professor of Sociology
University of Toronto
(Acting Director,
Center for Urban and Community Studies)
University of Toronto

Dr. P.C. Pineo, Chairman
Department of Sociology
McMaster University
Hamilton, Ontario

additional references on request.

JEFFA E. SHERIFF

Curriculum vitae

HOME ADDRESS:

3139 Princess Blvd.
BURLINGTON, Ontario
(416) 632-4394

DATE AND PLACE OF BIRTH:

30/7/1937: Blackheath, England
(Canadian Citizen since 1958)

MARITAL STATUS:

Married

PRE-UNIVERSITY EDUCATION:

Auckland House, Simla, India
St. Margaret's, Bushey, Herts, England
Glebe Collegiate, Ottawa, Canada.

UNIVERSITY EDUCATION:

McGill University, Montréal, Canada
(B.A. in Sociology and English, Summa cum
laude, 1958)
Université de Montréal, Montréal, Canada,
(Maîtrise ès Arts, Sociologie, Grande
distinction, 1966).
London School of Economics, London, England
(PhD, Sociology, 1968).

ACADEMIC AWARDS:

McGill University: Annie Macintosh Prize
Fourth year Faculty
scholarship
Université de Montréal: Bourse de la
Fondation Montpetit
London School of Economics: Commonwealth
Scholarship, 1965-68.

TEACHING EXPERIENCE:

1968-69 - Professeur assistant, Département de
Sociologie, Université de Montréal.
1970-71 - Part-time faculty member, University
of Maryland European Division.
1972 - Assistant Professor, McMaster University

RESEARCH EXPERIENCE:

a) Summer of 1964 and part of 1965:
Research assistant, Royal Commission on
Bilingualism and Biculturalism: Research on
the Canadian Civil Service.
b) 1968-69: Research Director for a comparative
study of university systems and student
movements in the French and English Canadian
milieux.
c) 1971 onwards: Research Officer, Civil Service
College, London Center (combined with some
teaching responsibilities) .

PUBLICATIONS:

"Factors affecting the impact of the Fulton Report", International Review of Administrative Sciences, No. 3, 1970, pp. 215-226.

"Outsiders in a closed career: The example of the British Civil Service", Public Administration, Vol. 50, Winter, 1972, pp. 397-417.

"Préférences, valeurs et différenciation intra-professionnelle", forthcoming in Canadian Review of Sociology and Anthropology.

(Translation) A General Introduction to Sociology by Guy Rocher. Toronto: Macmillan of Canada, 1972.

Civil Service Careers: Patterns and Success. London: HMSO, Civil Service College Series #2, 1973 (forthcoming).

Name: Dr. A. Waterhouse

Birth: April 13, 1936

Degrees:

B.A.(Hons.) Manchester, Architecture, 1959

M.Sc.(Pl.) Toronto, Urban & Regional Planning, 1966

Dr. Ing. Berlin, City Planning, 1968.

Academic and Other Relevant Appointments

1959-61 London County Council, Assistant Architect

1961-63 Central Mortgage and Housing Corporation,
Architect/Planner

1964-66 Canadian Michell Assoc., Toronto, Director,
Planning Department

1965-66 University of Toronto, Lecturer

1966-67 Government of Ethiopia, Housing Consultant

1966-67 Technische Universitat Berlin, Dozent

1969-72 University of Toronto, Assistant Professor

1969-72 University of Toronto, Associate Professor

1972 University of Toronto, Professor and Chairman

1969- United Nations, Technical Consultant

Publications

A. Books

A National Housing Program for the Empire of Ethiopia,
(with Fecadu Gedamu) 310 pp. Addis Ababa, Imperial
Ethiopian Government, 1966.

Terms of Reference for a Proposed Low Income Housing
Study. 2 vols. 123 pp. Addis Ababa, Imperial Ethiopian
Government, 1967.

"Eine Analytische Studie des Image West Berlins," in
.Stadt und Regionalplanung, ed. Peter Koller, Stuttgart
W. Kohlhaminer Verlag, 1971.

Urban Development in Mediaeval Europe, 25 pp. Monticello, Council of Planning Librarians, 1971.

Visual Change in Cities (Die Reaktion der Rewohner auf die aussere veränderung der Stadte. 184 pp. de Gruyter Verlag, Berlin and New York, 1972.

B. Papers in Referred Journals

"Archigram", Architectural Design, Vol. XXXV, 559-574, 1965.

"Visuelle Veränderungen in der Stadt", Archiv fuer Kommunalwissenschaften, No. 2, 1968. 235-242.

"Dominant Values and Urban Planning Policy", Journal of the Royal Town Planning Institute, Vol. 57, No. 1, 9-14 (January 1971).

C. Technical Reports

Several planning reports for communities and agencies in Ontario, Quebec, New York State, Manitoba, Bahamas, Germany and Africa. Of special interest:

Series of 4 background papers for National Housing Program in Ethiopia 1966=67.

Central Area Housing Study for Kassel, W. Germany 1968.

Design Model for the Planning of New Residential Activities in the Toronto Region. (Department of Treasury and Economics, Government of Ontafio. 1971.

An Appraisal of Two Conflitting Regional Policies: OAPADS and TCR (Department of Treasury and Economics) 1971

The Impact of Expressways Upon Adjacent Apartments (with J. Hitchcock) York/Toronto Universities Joint Program in Transportation. Research Report No. 10. Feb. 1973.

East of Bay Evaluation Report Ministry of Govt. Services Ont. Gov., March 1973.

A Brief Description of

"ERIS"

which is an

ECONOMIC SOAP EXPERIMENT SECTION

APPENDIX B

The Role of the T-80 and

A BRIEF DESCRIPTION OF "ERIS"

by

H. D. Lee & Associates Ltd.
Oakville, Ontario

October, 1972

A Brief Description of

"ERIS"

which is an

ECONOMIC ROAD IMPROVEMENT SELECTOR

Programme

for use on IBM 360-40 and
larger computer installations

by

N. D. Lea & Associates Ltd.
Oakville, Ontario

October, 1972

WHAT "ERIS" DOES

This brief describes the Economic Road Improvement Selector programme (ERIS) which has been developed by N. D. Lea & Associates Ltd. The ERIS programme is a modified version of the OPT programme which was developed earlier by N. D. Lea & Associates Ltd. principally for application in developing countries.

ERIS selects the optimum economic improvement for each section of road, and ranks, by priority, all such selected improvements throughout the road network which is submitted for analysis.

The optimum economic improvement for a section of road is determined using the criteria of the minimization of total transport costs. Included in the total transport costs are vehicle operating costs, road maintenance costs and capital costs. All such costs which are incurred during the study period are discounted to a common date for comparison.

The recommended improvements are ranked in order of rate-of-return where the rate-of-return is calculated as the interest rate which just equates the present worth of future benefits and the capital costs.

ERIS inputs and outputs are summarized in Figure 1.

A CANADIAN APPLICATION

ERIS has been installed by N. D. Lea & Associates Ltd. for continuing use on an ongoing basis by a regional municipality in Ontario, Canada. This municipality is using the programme in establishing priorities for the allocation of funds for improvement of both the urban and rural parts of the regional roads system.

The use of the programme in this case is to refine the earlier

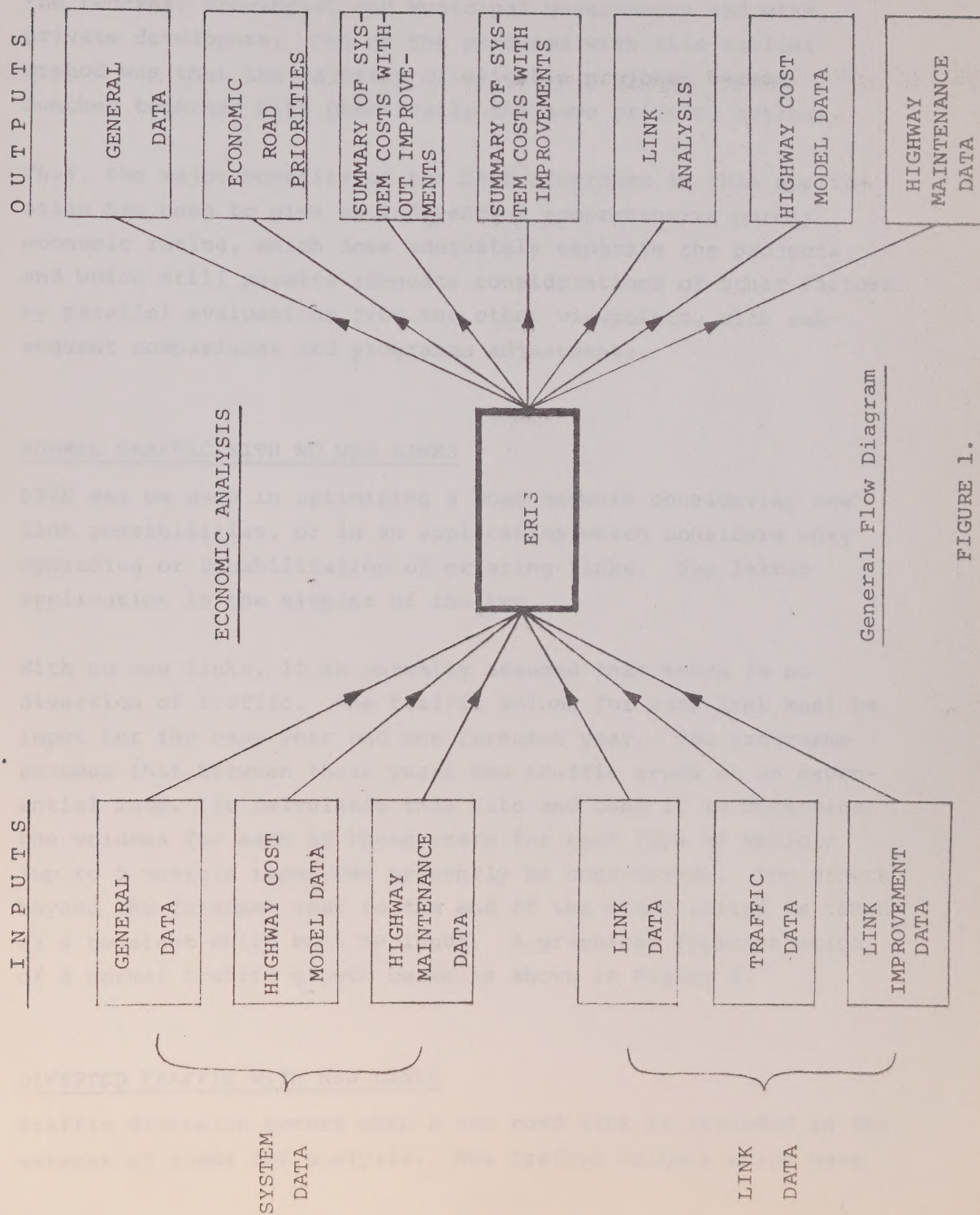


FIGURE 1.

method of determining priorities. The earlier method employed an arbitrary formula for combining both quasi economic considerations and other factors such as co-ordination of work with the Federal, Provincial and Municipal Governments and with private developers. One of the problems with this earlier method was that the majority of eligible projects became bunched together with practically the same priority ratings.

Thus, the major benefits of the ERIS programme in this application has been to give an independent comprehensive purely economic rating, which does adequately separate the projects and which still permits adequate considerations of other factors by parallel evaluations from the other viewpoints, with subsequent comparisons and programme adjustments.

NORMAL TRAFFIC WITH NO NEW LINKS

ERIS may be used in optimizing a road network considering new link possibilities, or in an application which considers only upgrading or rehabilitation of existing links. The latter application is the simpler of the two.

With no new links, it is normally assumed that there is no diversion of traffic. The traffic volume for each link must be input for the base year and one forecast year. The programme assumes that between these years the traffic grows at an exponential rate. It calculates this rate and uses it to determine the volumes for each of these years for each type of vehicle (up to 5 vehicle types can presently be considered). The growth beyond the forecast year to the end of the study period is taken as a constant which must be input. A graphical representation of a normal traffic growth curve is shown in Figure 2.

DIVERTED TRAFFIC WITH NEW LINKS

Traffic diversion occurs when a new road link is included in the network of roads for analysis. New traffic volumes which have

NORMAL TRAFFIC GROWTH CURVE

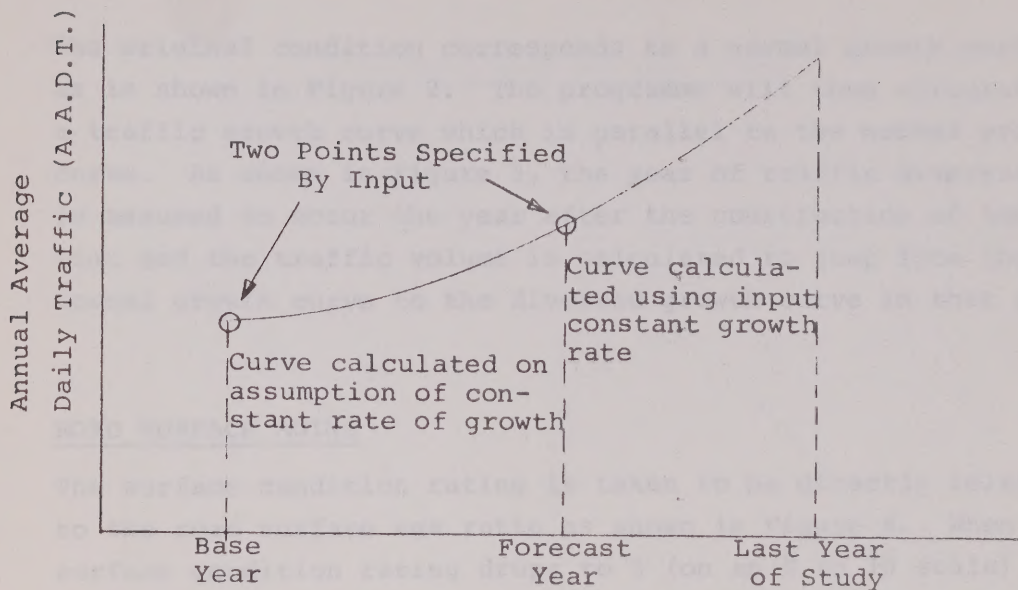


FIGURE 2

NORMAL & DIVERTED TRAFFIC GROWTH CURVE

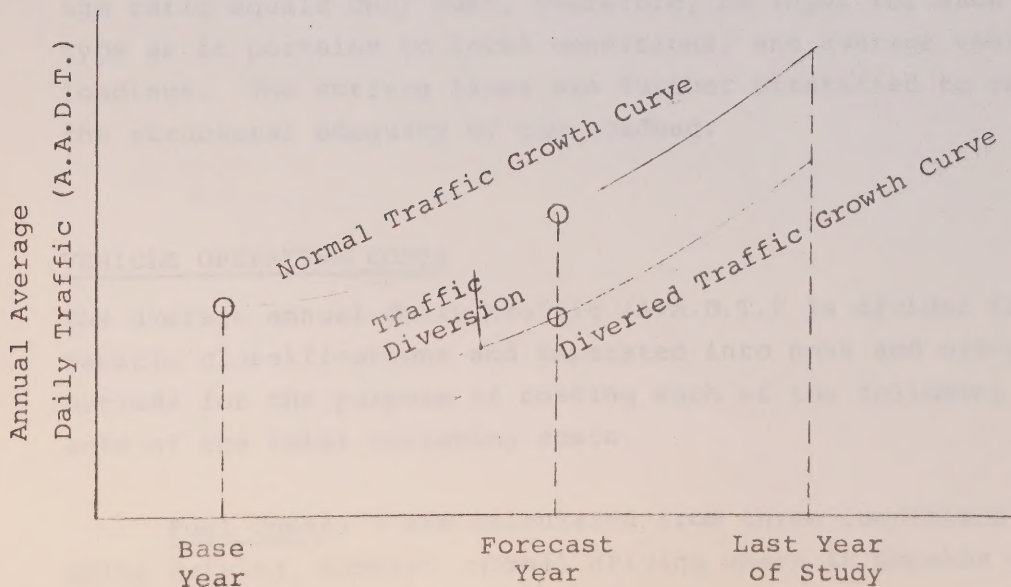


FIGURE 3

been adjusted for this diversion must be input for all links affected and for one forecast year only.

The original condition corresponds to a normal growth curve, as is shown in Figure 2. The programme will then calculate a traffic growth curve which is parallel to the normal growth curve. As shown in Figure 3, the year of traffic diversion is assumed to occur the year after the construction of the new link and the traffic volume is calculated to jump from the normal growth curve to the diverted growth curve in that year.

ROAD SURFACE AGING

The surface condition rating is taken to be directly related to the road surface age ratio as shown in Figure 4. When the surface condition rating drops to 5 (on an 0 to 10 scale) it is assumed that the useful life of the surface has been reached and that the road surface age ratio has reached one. The rate of road surface aging is related to the local climatic conditions and the total vehicle loadings, and the influence of each factor varies by surface types.

The surface life (i.e. the age in years when the road surface age ratio equals one) must, therefore, be input for each surface type as it pertains to local conditions, and average vehicle loadings. The surface lives are further stratified to reflect the structural adequacy of the roadbed.

VEHICLE OPERATING COSTS

The average annual daily traffic (A.A.D.T.) is divided into five vehicle classifications and separated into peak and off-peak periods for the purpose of costing each of the following components of the total operating costs.

Fuel Costs: - are calculated from three conditions of daily driving, namely: normal driving where it depends on

EFFECTIVE ROAD SURFACE AGING

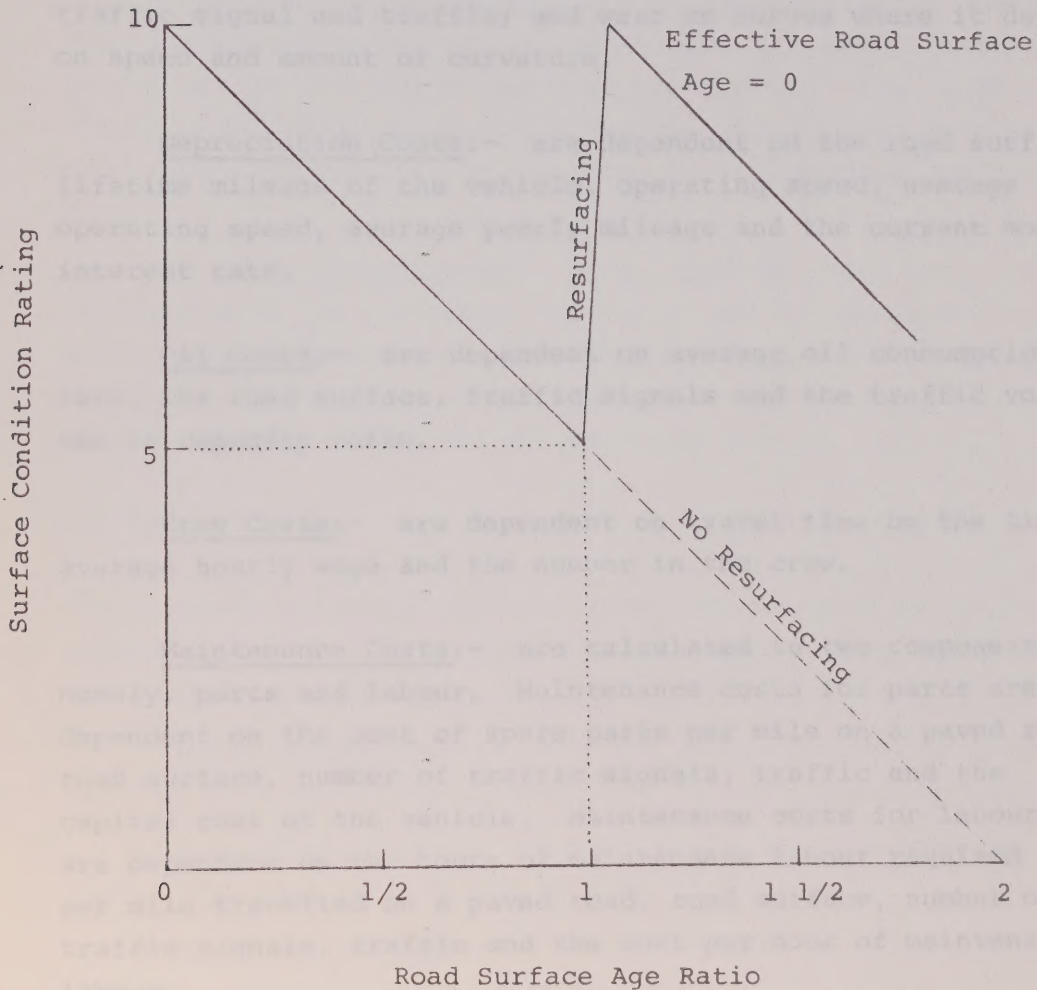


Figure 4

vehicle weight, terrain and road surface; stopping operations where it depends on vehicle weight, traffic signals and traffic; and idling where it depends on vehicle type and traffic.

Tire Costs:- are calculated from three conditions of daily driving, namely: normal driving where it depends on speed and road surface; stopping operations where it depends on traffic signal and traffic; and wear on curves where it depends on speed and amount of curvature.

Depreciation Costs:- are dependent on the road surface, lifetime mileage of the vehicle, operating speed, average operating speed, average yearly mileage and the current money interest rate.

Oil Costs:- are dependent on average oil consumption rate, the road surface, traffic signals and the traffic volume to capacity ratio.

Crew Costs:- are dependent on travel time on the link, average hourly wage and the number in the crew.

Maintenance Costs:- are calculated in two components; namely, parts and labour. Maintenance costs for parts are dependent on the cost of spare parts per mile on a paved road, road surface, number of traffic signals, traffic and the capital cost of the vehicle. Maintenance costs for labour are dependent on the hours of maintenance labour required per mile travelled on a paved road, road surface, number of traffic signals, traffic and the cost per hour of maintenance labour.

Accident Costs:- are dependent on the accident rate per million vehicle miles of travel and the average cost per accident.

Fixed Costs:- are dependent on annual license fees, average annual distance travelled, average operating speed and average operating speed on the link.

ROAD MAINTENANCE COSTS

The total roadway maintenance costs are divided into two classifications; namely, annual or normal maintenance, and periodic maintenance. These classifications are further subdivided into road surface types.

Annual or Normal Maintenance:- is composed of roadside maintenance per mile, winter maintenance per mile (where applicable), bridge and culvert maintenance per mile, safety controls per mile and the road surface maintenance per lane mile which depends on age and type of road surface and traffic.

Periodic Maintenance:- is a complete resurfacing which is assumed to be carried out when the age of road surface equals its life after the initial planning period (usually about 3 to 5 years). A road surface salvage value is calculated in the final year of the study period.

CAPITAL COSTS

The capital or rehabilitation costs are composed of three elements; namely, right-of-way costs, resurfacing costs and construction costs.

Right-of-Way Costs:- are the costs incurred in conjunction with an improvement during the initial planning period.

Resurfacing Costs:- are the costs to resurface the road during the initial planning period.

Construction Costs:- are the balance of all rehabilitation and reconstruction costs excluding right-of-way and resurfacing. Salvage values are calculated in the final year of the study period.

ECONOMIC ANALYSIS

The vehicle operating, road maintenance and capital costs are calculated for each year of the study period on every road link being analysed, for every condition of possible upgrading and for both the traffic condition of normal traffic only and that of normal traffic plus diversions.

If there are no new links in the system and no traffic diversions because of improvements, then the benefits on each link is simply the difference between the total cost with and without improvement. The optimum improvement on each link is that giving the minimum present worth of the total cost, and the total system benefits is the sum of the link benefits. For each link the rate-of-return for the optimum improvement is calculated as that giving a present value of operating and maintenance costs which is just equal to the total capital cost. The projects are listed by link in order of declining rate-of-return and the rate-of-return on the entire system is calculated in a similar way to that of the links. For each link and for the total system the benefit cost ratio and the net present worth benefits are also calculated using the opportunity cost of capital which is an input. A detailed flow of this economic analysis is attached.

In order to determine if a new road link is economically justified in a network, it is necessary to undertake a sub-analysis. In a sub-analysis, a sub-system of links is identified which is directly affected by the diversion of traffic if a new link is constructed. This does not include traffic diversion because of upgrading. The sub-system of links is optimized without the new link for normal traffic conditions. Then the sub-system of links is optimized with the new link and corresponding traffic diversions included. If the total transport cost is less for the sub-system optimization which

included the new link, then the new link is economically justified, otherwise not. The benefits assigned to the new link is thus the difference in sub-system benefits with and without the new link. All other calculations are as for the system without diversions. The above calculations are all carried out within the programme.

If there is traffic diversion due to improvement, as well as due to new link(s), then the process is somewhat complex. For this purpose a slightly modified programme is used which is not illustrated on the detailed flow diagram. The traffic information must be input in greater detail. Each element of diverted traffic is identified as to route before and after diversion and is quantified. Then, for each such element, the cost savings because of diversion is allocated as a benefit to the links over which the diverted traffic travels, in proportion to the capital investment in those facilities. These benefits due to diversion are calculated for the unimproved network costs before and the fully improved network costs after. The benefits to the non-diverted traffic are calculated separately as though that was the only traffic on the network. The benefits from diverted and non-diverted traffic are then summed and economic indicators calculated for each link and for the whole network as before.

RUNNING TIMES AND COSTS

The ERIS programme requires 200K bites (50K words) of computer core in order to be run. This eliminates mini-type computers for the application of this programme. It can, however, be adapted with a minimal amount of effort to most larger computers, such as:

- IBM 360-40 and larger
- CDC 6000 Series
- Honeywell 6000 Series
- PDP 10

From example runs on an IBM 360-75 it has been determined that approximately 1 second of computer time is required for each link being analyzed. This would increase to approximately 15 seconds per link on an IBM 360-50. If all printouts are requested, the printing cost is approximately half of the total cost.

For an example run, the following times and costs were incurred:

Type of Machine	IBM 360-75
Number of Links	56
Computer Time	45 Seconds
C.P.U. Cost	\$15.00
Printing Cost	\$15.00
Total Cost	\$30.00

EXAMPLE ANALYSIS USING "ERIS"

An application of ERIS which considers only the upgrading or rehabilitation of existing links with no diversions of traffic is shown for illustrative purposes. In the example analysis 56 road links were considered, but only the analysis for 4 links is shown in the example output.

INPUTS

The input data requirements for "ERIS" are as summarized in Figure 1. All input data is shown as part of the printed output produced.

General Data:- which is shown on Output 2, describes the framework for the analysis undertaken, such as, whether it is a sub-analysis to test the economic feasibility of constructing a new road link in the network or a regular analysis to determine the least total cost improvement for each link being analysed, the years for which traffic data is available and discount rates per annum.

Highway Cost Model Data:- is summarized on Output 14 and it describes vehicle parameters for each vehicle type being analysed for the purposes of calculating vehicle operating costs on each road link.

Highway Maintenance Data:- is summarized on Output 15 as required to calculate road maintenance costs for each surface type being analysed.

Link Data:- is the existing physical characteristics of each road link as shown on Outputs 6, 8, 10, & 12, and describes such characteristics as road classification, surface type, terrain, surface condition and structural adequacy.

Traffic Data:- is a summary of traffic characteristics for the existing conditions and forecasted future conditions as shown on Outputs 6 to 13 under "Traffic Data" and the calculated yearly "Daily Volume".

Link Improvement Data:- is the alternative physical characteristics of each road link shown under "Link Data" on Outputs 7, 9, 11, & 13.

OUTPUTS

All output produced from an analysis run of "ERIS" is as summarized in Figure 1. All output has been printed for the example analysis.

General Data:- is a summary of the input information and is shown on Output 2.

Economic Road Priorities:- is a detailed listing of all the recommended improvements ranked in order of rate-of-return giving detailed information on section description, improved class, type of improvement, capital cost and rate-of-return as shown on Output 3.

Summary of System Costs Without Improvements:- is shown as a summary on Output 4 of the yearly vehicle operating costs and road maintenance costs for the system of roads without any capital improvements.

Summary of System Costs With Improvements:- is shown on Output 5 as a summary of yearly vehicle operating costs, road maintenance costs and capital costs for the system of roads with all recommended improvements included.

Link Analysis:- is shown on Outputs 6 to 13 and it is the summary of existing conditions and of alternative improvements for 4 of the links being analysed. Each detailed analysis shows the yearly vehicle operating costs, road maintenance costs and capital costs (for alternative improvements).

Highway Cost Model Data:- as shown on Output 14 is a summary of the input information.

Highway Maintenance Data:- as shown on Output 15 is a summary of the input information.

*
* OTTAWA-CARLETON ROAD BUDGET *
*
* 1972 TO 1976 - SEPT 11, 1972 *
*

USING

EEEE	RRRR	I	SSSS
F	R	I	S
E	R	I	S
EEE	RRRR	I	SSS
E	R	I	S
E	R	I	S
EEEE	RR	I	SSSS

THE

ECONOMIC ROAD IMPROVEMENT SELECTOR

BY

N. D. LEA & ASSOCIATES

* GENERAL DATA *

Only required where a
new link causes
traffic diversion

SUB-ANALYSIS

RUN NUMBER	NO
NUMBER OF LINKS	56
BASE YEAR	1971
FORECAST YEAR	1981
INITIAL PLANNING PERIOD	1972-1976
YEAR OF CAPITAL EXPENDITURE	1974
YEAR OF TRAFFIC DIVERSION	1975
YEAR OF COMPLETION OF STUDY PERIOD	1992
YEAR TO WHICH COSTS ARE DISCOUNTED	1972
DISCOUNT RATE PER ANNUM (%)	11
ANNUAL TRAFFIC GROWTH RATE BEYOND FORECAST YEAR (%)	6

Years for which
traffic data is available

REGIONAL MUNICIPALITY OF OTTAWA - CARLETON

 * ECONOMIC ROAD PRIORITIES *
 * * * * *
 * PERIOD 1972 TO 1976 *
 * * * * *

SECTION NO.	SECTION DESCRIPTION	IMPROVED CLASS	TYPE OF IMPROVEMENT	CAPITAL COST (\$1000)	RATE OF RETURN
204	FROM RIVER RD TO ST LAURENT BLVD	4UCU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	980.	627.0%
606	FROM ST LAURENT BLVD TO BLAIR RD	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	1265.	293.7%
363	FROM BANK ST TO ELGIN ST	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	271.	158.1%
22	FROM RIVERSIDE DR TO CHAMBERLAIN ST	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	700.	157.2%
570	FROM QUEENSWAY REGIONAL RD 34	2RAU	RESURFACING AND MINOR WIDENING	140.	144.9%
109	FROM QUEENSWAY FISHER AVE TO W/L ORLEANS	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	1220.	134.8%
12	FROM DYNES RD TO CARLING AVE	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	350.	115.0%
263	FROM SPYTH RD TO INDUSTRIAL AVE	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	1066.	65.0%
244	FROM CITY LIMITS TO PINECREST RD	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	310.	57.5%
349	FROM QUEENSWAY TO FALLIS AVE	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	904.	54.8%
563	FROM CONROY RD TO RUSSELL RD	2RAU	BASE AND SURFACE	72.	53.7%
335	FROM REGIONAL RD 26 TO REGIONAL RD 28	6UAD	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	675.	50.7%
226	FROM DALHOUSIE ST TO CHARLOTTE ST	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	3300.	47.0%
42	FROM CITY LIMITS TO BLAIR RD	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	623.	43.8%
489	FROM RIVER RD TO JULIANA RD	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	1128.	42.5%
139	FROM SLACK RD TO NORICE ST	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	2692.	41.2%
88	FROM PRINCE OF WALES DR TO RIVERSIDE DR	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	430.	40.9%
280	FROM CARLING AVE TO SCOTT ST	4UAD	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	1502.	40.5%
340	FROM BONLEVILLE RD TO LEOPOLDS DR	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	510.	36.7%
130	FROM HERON RD TO CONROY RD	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	2000.	34.9%
347	FROM CITY LIMITS TO RICHMOND RD	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	1700.	32.3%
31	FROM BANK ST TO HERON RD	4UAU	COMPLETE RECONSTRUCTION TO DESIGN STANDARD	992.	30.3%
597	FROM HWY 7 W/L LIMITS TO 100 FT W GREENBANK	2RAU	BASE AND SURFACE	1000.	20.4%

Details given on following sheets

 * SUMMARY OF SYSTEM COSTS *
 * WITHOUT IMPROVEMENTS *

Rehabilitation
 or Reconstruction - All zero in
 this case

EXISTING CONDITIONS - NORMAL TRAFFIC

Periodic

Normal

YR	MAINTENANCE COSTS			CAPITAL COSTS		TOTAL COSTS (\$1000)
	OPERATING COSTS (\$1000)	RESURFACING (\$1000)	ANNUAL (\$1000)	M.O.M. (\$1000)	RESURFACING (\$1000)	
1972	54035.	0.	558.	0.	0.	54593.
1973	65767.	0.	580.	0.	0.	66347.
1974	73490.	0.	604.	0.	0.	74094.
1975	82271.	0.	629.	0.	0.	82900.
1976	92120.	0.	654.	0.	0.	92774.
1977	103280.	1276.	678.	0.	0.	105233.
1978	100498.	0.	470.	0.	0.	100968.
1979	115417.	140.	530.	0.	0.	116591.
1980	133995.	159.	543.	0.	0.	134697.
1981	154880.	56.	577.	0.	0.	155513.
1982	174946.	136.	595.	0.	0.	175676.
1983	196417.	516.	651.	0.	0.	197583.
1984	212270.	262.	664.	0.	0.	213096.
1985	234458.	403.	619.	0.	0.	240480.
1986	270045.	210.	600.	0.	0.	270854.
1987	302916.	282.	647.	0.	0.	303847.
1988	342040.	236.	647.	0.	0.	342932.
1989	361093.	320.	685.	0.	0.	362098.
1990	425839.	270.	650.	0.	0.	426758.
1991	478676.	435.	727.	0.	0.	479838.
1992	539419.	244.	710.	0.	0.	540383.
SALVAGE VALUE		990.		0.	0.	990.
TOTAL LESS SALVAGE VALUE	4504374.	3969.	12918.	0.	0.	4561260.
PRESENT VALUES DISCOUNTED AT 11%	1267480.	5369.		0.	0.	1294380.

OUTPUT 4. SYSTEM SUMMARY - NO REHABILITATION

N.B.
Total traffic must
in system
not change.

SUMMARY OF SYSTEM COSTS
WITH RECOMMENDED IMPROVEMENTS

Periodic

Rehabilitation
or upgrading.

LEAST COST ALTERNATIVES - NORMAL AND DIVERTED TRAFFIC

YEAR	Normal			CAPITAL COSTS		TOTAL COSTS
	OPERATING COSTS (\$1000)	MAINTENANCE COSTS (\$1000)	RESURFACING (\$1000)	ANNUAL (\$1000)	R.O.M. (\$1000)	
1972	59035.	0.	0.	0.	0.	59035.
1973	65767.	0.	0.	0.	0.	66347.
1974	73490.	0.	0.	7406.	0.	109610.
1975	58152.	0.	0.	0.	0.	58664.
1976	63056.	0.	0.	0.	0.	63582.
1977	68574.	308.	0.	0.	0.	69427.
1978	74005.	0.	0.	0.	0.	74517.
1979	81621.	115.	0.	0.	0.	82279.
1980	90347.	35.	0.	0.	0.	90928.
1981	103216.	8.	0.	0.	0.	103799.
1982	113674.	21.	0.	0.	0.	114282.
1983	125690.	43.	0.	0.	0.	126355.
1984	137631.	77.	0.	0.	0.	138336.
1985	151466.	8.	0.	0.	0.	152141.
1986	166407.	110.	0.	0.	0.	167200.
1987	183720.	171.	0.	0.	0.	184608.
1988	202460.	0.	0.	0.	0.	203172.
1989	228217.	317.	0.	0.	0.	229304.
1990	250527.	463.	0.	0.	0.	251730.
1991	275334.	330.	0.	0.	0.	278392.
1992	305041.	173.	0.	0.	0.	305905.
SALVAGE VALUE		1168.				9760.

TOTAL LESS SALVAGE VALUE	2877426.	1010.	1763.	2483.	2918404.
PRESENT VALUES DISCOUNTED AT 11%	887250.	5237.	1456.	21047.	920656.

- 1. RATE OF RETURN = 56.25%
- 2. BENEFIT/COST = 14.86
- 3. NET BENEFITS = 373724.44

REGIONAL MUNICIPALITY OF OTTAWA - CARLETON

* LINK ANALYSIS - SECTION 443 *

REGIONAL RD 8 FROM HWY 417 TO LIMOGES RD
ALTERNATIVE NO. 1: NORMAL AND DIVERTED TRAFFIC

HASE AND SURFACE
CAPITAL COST (\$1000) 400.
SERVICE LIFE CONSTRUCTION 10 YEARS

RATE OF RETURN = 0.5%
BENEFIT/COST = 0.4
NET BENEFITS (\$1000) = -179.4

Section

LINK DATA

JURISDICTION	CLASS	CLASS	SPEED ZONE (M.P.H.)	SURFACE TYPE	TERRAIN	TRAFFIC SIGNALS	CURVATURE (DEGREES)	SURFACE CONDITION	STRUCTURAL ADEQUACY
2	2RAU	2RAU	50.	5	1	0.	55.	10	20

Low Class Bitumen

Both raised to maximum

TRAFFIC DATA

D.M.V. DIRECTIONAL CAPACITY (ONE-WAY)
SPLIT

Increased

(950)

CLASSIFICATION

TRUCKS

HEAVY

BUSES

RATE (PER MILLION)

MILES

UNIT COST (\$1000)

Periodic

OPERATING COSTS (\$1000)

RESURFACING

ANNUAL (\$1000)

Normal

R.O.M.

RESURFACING (\$1000)

CONSTRUCTION (\$1000)

TOTAL COSTS (\$1000)

DAILY VOLUME

YEAR	OPERATING COSTS (\$1000)	RESURFACING (\$1000)	ANNUAL (\$1000)	R.O.M.	RESURFACING (\$1000)	CONSTRUCTION (\$1000)	TOTAL COSTS (\$1000)	DAILY VOLUME
1971	65.	0.	15.	0.	0.	0.	79.	174.
1972	67.	0.	15.	0.	0.	0.	82.	181.
1973	70.	0.	15.	0.	77.	323.	485.	188.
1974	74.	0.	17.	0.	0.	0.	62.	196.
1975	44.	0.	17.	0.	0.	0.	64.	204.
1976	46.	0.	17.	0.	0.	0.	66.	212.
1977	48.	0.	17.	0.	0.	0.	68.	220.
1978	51.	0.	17.	0.	0.	0.	70.	229.
1979	53.	0.	18.	0.	0.	0.	73.	238.
1980	55.	0.	18.	0.	0.	0.	75.	248.
1981	58.	0.	18.	0.	0.	0.	79.	258.
1982	61.	0.	18.	0.	0.	0.	83.	273.
1983	65.	0.	18.	0.	0.	0.	88.	290.
1984	69.	0.	18.	0.	0.	0.	92.	307.
1985	74.	0.	18.	0.	0.	0.	97.	326.
1986	79.	0.	18.	0.	0.	0.	103.	345.
1987	84.	0.	19.	0.	0.	0.	108.	366.
1988	89.	0.	19.	0.	0.	0.	114.	388.
1989	95.	0.	19.	0.	0.	0.	121.	411.
1990	102.	0.	19.	0.	0.	0.	128.	436.
1991	108.	0.	19.	0.	0.	0.	135.	462.
1992	116.	0.	19.	0.	0.	0.	0.	490.
SALVAGE VALUE								

TOTAL LESS SALVAGE VALUE 1500.

PRESENT VALUES DISCOUNTED AT 11% 568.

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* LINK ANALYSIS - SECTION 425 *

REGIONAL RD 6 FROM REGIONAL RD 25 TO HWY 31

Section

LINK DATA

EXISTING CONDITIONS - NORMAL AND DIVERTED TRAFFIC

CLASSIFICATION	LENGTH (MILES)	CLASS	SPEED ZONE (K.P.H.)	SURFACE TYPE	GRADE	TRAFFIC SIGNALS	CURVATURE (DEGREES)	SURFACE CONDITION	STRUCTURAL ADEQUACY
2	4.3	2HAU	50.	Gravel	Flat	0.	21.	Bad	Bad

TRAFFIC DATA

D.M.V. DIRECTIONAL SPLIT	CAPACITY (ONE-WAY)	CLASSIFICATION(%)	TRUCKS	AUTOS	LIGHT	MEDIUM	HEAVY	BUSES	RATE (PER MILLION) MILES	UNIT COST (\$1000)	ACCIDENTS
(X) 16.	737.	7.	87.	7.	4.	1.	1.	1.	2.8	0.9	Existing Condition

Periodic

Normal

YEAR	OPERATING COSTS (\$1000)	MAINTENANCE COSTS (\$1000)	ANNUAL RESURFACING (\$1000)	R.O.M. (\$1000)	RESURFACING (\$1000)	CONSTRUCTION (\$1000)	TOTAL COSTS (\$1000)	DAILY VOLUME
1971	279.	0.	21.	0.	0.	0.	300.	674.
1972	296.	0.	21.	0.	0.	0.	317.	715.
1973	314.	0.	22.	0.	0.	0.	336.	758.
1974	333.	0.	22.	0.	0.	0.	356.	804.
1975	354.	0.	23.	0.	0.	0.	377.	853.
1976	375.	31.	24.	0.	0.	0.	430.	904.
1977	266.	0.	13.	0.	0.	0.	279.	959.
1978	423.	31.	25.	0.	0.	0.	478.	1017.
1979	300.	0.	13.	0.	0.	0.	313.	1079.
1980	477.	31.	26.	0.	0.	0.	533.	1144.
1981	338.	0.	14.	0.	0.	0.	352.	1213.
1982	537.	31.	28.	0.	0.	0.	636.	1266.
1983	382.	0.	14.	0.	0.	0.	396.	1363.
1984	604.	31.	29.	0.	0.	0.	664.	1445.
1985	430.	0.	15.	0.	0.	0.	446.	1531.
1986	681.	31.	31.	0.	0.	0.	743.	1623.
1987	486.	0.	16.	0.	0.	0.	502.	1721.
1988	768.	31.	33.	0.	0.	0.	832.	1824.
1989	549.	0.	17.	0.	0.	0.	566.	1933.
1990	866.	31.	36.	0.	0.	0.	932.	2049.
1991	621.	0.	17.	0.	0.	0.	636.	2172.
1992								2303.
SALVAGE VALUE		15.		0.	0.	0.	15.	
TOTAL LESS SALVAGE VALUE	9679.	230.	461.	0.	0.	0.	10370.	
PRESENT VALUES DISCOUNTED AT 11%	3461.	76.	192.	0.	0.	0.	3729.	

* LINK ANALYSIS - SECTION 425 *

REGIONAL RD 6 FROM REGIONAL RD 25 TO HWY 31

ALTERNATIVE NO. 1: NORMAL AND DIVERTED TRAFFIC

BASE AND SURFACE CAPITAL COST (\$1000) 506.
SERVICE LIFE CONSTRUCTION 10 YEARS
RATE OF RETURN 23.42
BENEFIT/COST 1.8
NET BENEFITS (\$1000) = 333.9

Both raised to maximum

Low Class Bitumen Flat

TRAFFIC DATA

COMPOSITION	LENGTH (MILES)	CLASS	SPEED ZONE (M.P.H.)	SURFACE TYPE	TRAFFIC SIGNALS	CURVATURE (DEGREES)	STRUCTURAL ADEQUACY
2	4.3	2RAU	50.	5	0.	21.	20

Upgraded Condition!

TRAFFIC DATA		CAPITAL COSTS		MAINTENANCE COSTS		ANNUAL RESURFACING		TOTAL COSTS (\$1000)		DAILY VOLUME	
YEAR	OPERATING COSTS (\$1000)	RESURFACING (\$1000)	ANNUAL (\$1000)	MAINTENANCE (\$1000)	RESURFACING (\$1000)	ANNUAL (\$1000)	MAINTENANCE (\$1000)	TOTAL (\$1000)	RESURFACING (\$1000)	ANNUAL (\$1000)	DAILY VOLUME
1971	279.	0.	279.	21.	0.	279.	21.	300.	0.	0.	674.
1972	296.	0.	296.	21.	0.	296.	21.	317.	0.	0.	715.
1973	314.	0.	314.	22.	0.	314.	22.	342.	0.	0.	758.
1974	204.	0.	204.	19.	0.	204.	19.	225.	0.	0.	804.
1975	218.	0.	218.	19.	0.	218.	19.	237.	0.	0.	853.
1976	233.	0.	233.	19.	0.	233.	19.	252.	0.	0.	904.
1977	249.	0.	249.	19.	0.	249.	19.	268.	0.	0.	959.
1978	266.	0.	266.	20.	0.	266.	20.	286.	0.	0.	1017.
1979	285.	0.	285.	20.	0.	285.	20.	305.	0.	0.	1079.
1980	305.	0.	305.	20.	0.	305.	20.	325.	0.	0.	1144.
1981	326.	0.	326.	21.	0.	326.	21.	347.	0.	0.	1213.
1982	350.	0.	350.	21.	0.	350.	21.	371.	0.	0.	1286.
1983	375.	0.	375.	21.	0.	375.	21.	397.	0.	0.	1363.
1984	405.	0.	405.	22.	0.	405.	22.	427.	0.	0.	1445.
1985	441.	0.	441.	22.	0.	441.	22.	463.	0.	0.	1531.
1986	480.	0.	480.	23.	0.	480.	23.	503.	0.	0.	1623.
1987	523.	0.	523.	23.	0.	523.	23.	546.	0.	0.	1721.
1988	571.	83.	654.	24.	0.	654.	24.	677.	0.	0.	1824.
1989	502.	0.	502.	19.	0.	502.	19.	521.	0.	0.	1933.
1990	539.	0.	539.	20.	0.	539.	20.	559.	0.	0.	2049.
1991	580.	0.	580.	20.	0.	580.	20.	600.	0.	0.	2172.
1992											2303.
SALVAGE VALUE				65.				65.			

Normal Upgrading

Normal

Periodic

Increased

950.

TOTAL LESS SALVAGE VALUE 7742.

PRESENT VALUES DISCOUNTED AT 11% 2794.

cf. with 372.9 if not upgraded.

Section 425 - 110KRAFDN

* LINK ANALYSIS - SECTION 493 *

ACROSS STREET FROM QUEENSWAY TO HWY 17

Section 1

PAVING CONDITIONS - NORMAL AND DIVERTED TRAFFIC

Fair to Good Fair

High Class Bitumen

CLASS	SPUR (C.P.A.)	TYPE	TRAFFIC SIGNALS	CONCRETE (CULVERTS)	STREET CONDITION	STRUCTURAL Adequacy
2	20A	3	0.	0.	6	10

Existing Conditions

CLASSIFICATION (2)				ACCIDENTS	
TRUCKS				HAZ. MILLS	HAZ. COST
AUTOS	LIGHT	MEDIUM	HEAVY	(PER MILLION)	(X1000)
87.	7.	4.	1.	2.8	0.9

Periodic Maintenance Costs Normal

YEAR	OPERATING COSTS (\$1000)	REPAIRING COSTS (\$1000)	ANNUAL (\$1000)	P.O.M. (\$1000)	RESURFACING (\$1000)	CONSTRUCTION (\$1000)	TOTAL COSTS (\$1000)	DAILY VOLUME
------	--------------------------	--------------------------	-----------------	-----------------	----------------------	-----------------------	----------------------	--------------

1971	22.	0.	1.	0.	0.	0.	23.	2313.
1972	24.	0.	1.	0.	0.	0.	25.	2471.
1973	26.	0.	1.	0.	0.	0.	27.	2641.
1974	29.	0.	1.	0.	0.	0.	29.	2822.
1975	31.	0.	1.	0.	0.	0.	32.	3015.
1976	34.	0.	1.	0.	0.	0.	36.	3222.
1977	37.	0.	1.	0.	0.	0.	39.	3442.
1978	39.	0.	1.	0.	0.	0.	42.	3678.
1979	41.	0.	1.	0.	0.	0.	45.	3930.
1980	43.	0.	1.	0.	0.	0.	48.	4199.
1981	45.	0.	1.	0.	0.	0.	51.	4487.
1982	47.	0.	1.	0.	0.	0.	54.	4756.
1983	49.	0.	1.	0.	0.	0.	57.	5042.
1984	51.	0.	1.	0.	0.	0.	60.	5344.
1985	53.	0.	1.	0.	0.	0.	63.	5665.
1986	55.	0.	1.	0.	0.	0.	66.	6005.
1987	57.	0.	1.	0.	0.	0.	69.	6365.
1988	59.	0.	1.	0.	0.	0.	72.	6747.
1989	61.	0.	1.	0.	0.	0.	75.	7152.
1990	63.	0.	1.	0.	0.	0.	78.	7581.
1991	65.	0.	1.	0.	0.	0.	81.	8035.
1992	67.	0.	1.	0.	0.	0.	84.	8518.

SALVAGE VALUE

TOTAL LESS SALVAGE VALUE	941.
PRESENT VALUES DISCOUNTED AT 11%	326.

* LINK ANALYSIS - SECTION 493 *

2 LANE SIDE RD

FROM WATSONWAY

TO HWY 17

ALTERNATIVE NO. 1: NORMAL AND DIVERTED TRAFFIC

COMPLETE RECONSTRUCTION TO DESIGN STANDARD
CAPITAL COST (\$1000) 110.
ANNUAL LIFE CONSTRUCTION 20 YEARS
Widened to 4 lanes High Class Bitumen

RATE OF RETURN = 5.6%
BENEFIT/COST = 0.7
NET BENEFITS (\$1000) = -30.3

Both raised to maximum

TRAFFIC DATA
CLASSIFICATION LEGAL (M.P.H.) TYPE SURFACE CONDITION SURFACE ADEQUACY
2 (Z) 60. (400) 3 1 0. 10 20

Conditions after Widening & Rehabilitation

TRAFFIC DATA		CLASSIFICATION (Z)		ACCIDENTS	
(Z)	(M.P.H.)	TRUCKS	BUSES	RATE (PER MILLION MILES)	DAILY COST (\$1000)
12.	60.	LIGHT 7. MEDIUM 4. HEAVY 1.	1.	2.8	0.9

Increased

1500.

Periodic

OPERATING COSTS (\$1000)
MAINTENANCE COSTS (\$1000)
ANNUAL (\$1000)

Normal

Widening & Rehabilitation

TOTAL COSTS (\$1000)
DAILY VOLUME

YEAR	OPERATING COSTS (\$1000)	MAINTENANCE COSTS (\$1000)	ANNUAL (\$1000)	H.O.M. (\$1000)	RESURFACING (\$1000)	CONSTRUCTION (\$1000)	TOTAL COSTS (\$1000)	DAILY VOLUME
1971	22.	0.	1.	0.	0.	0.	23.	2513.
1972	24.	0.	1.	0.	0.	0.	25.	2471.
1973	26.	0.	1.	14.	4.	92.	137.	2641.
1974	20.	0.	1.	0.	0.	0.	20.	2822.
1975	21.	0.	1.	0.	0.	0.	22.	3015.
1976	23.	0.	1.	0.	0.	0.	23.	3222.
1977	24.	0.	1.	0.	0.	0.	25.	3442.
1978	26.	0.	1.	0.	0.	0.	27.	3678.
1979	28.	0.	1.	0.	0.	0.	29.	3930.
1980	30.	0.	1.	0.	0.	0.	31.	4199.
1981	32.	0.	1.	0.	0.	0.	33.	4487.
1982	35.	0.	1.	0.	0.	0.	35.	4756.
1983	37.	0.	1.	0.	0.	0.	36.	5042.
1984	39.	0.	1.	0.	0.	0.	38.	5344.
1985	42.	0.	1.	0.	0.	0.	40.	5665.
1986	45.	0.	1.	0.	0.	0.	43.	6005.
1987	48.	0.	1.	0.	0.	0.	46.	6365.
1988	51.	0.	1.	0.	0.	0.	49.	6747.
1989	55.	0.	1.	0.	0.	0.	52.	7152.
1990	59.	0.	1.	0.	0.	0.	56.	7581.
1991	63.	0.	1.	0.	0.	0.	59.	8035.
1992		0.	1.	0.	0.	0.	64.	8518.
SALVAGE VALUE								
TOTAL LESS SALVAGE VALUE				11.	0.	9.	21.	
753.				3.	3.	83.	855.	
PRESENT VALUES DISCOUNTED AT 11%				10.	3.	74.	359.	
262.								

cf. with 326 if not widened & rehabilitated

Output 11 Section 493. Widened and Rehabilitated

* LINK ANALYSIS - SECTION 12 *

Section

NITA VISTA DR FROM SWYTH RD TO INDUSTRIAL AVE

EXISTING CONDITIONS - NORMAL AND DIVERTED TRAFFIC

High Class Bitumen

Fair to Good

Poor to Fair

JURISDICTION	LENGTH (MILES)	CLASS	SPEED ZONE (M.P.H.)	SURFACE TYPE	TERRAIN	TRAFFIC SIGNALS	CURVATURE (DEGREES)	SURFACE CONDITION	STRUCTURAL ADEQUACY
2	0.9	4000	30.	3	1	1.	133.	6	7

Existing Conditions

TRAFFIC DATA	CLASSIFICATION	ACCIDENTS	HAZARD	UNIT COST
CLASS	CAPACITY (VEH/HR)	TRUCKS	(PER MILLION)	
(2)		AUTOS	HAZARD	
10.	1500.	67.	1.	0.9

Periodic Maintenance Costs

YEAR	OPERATING COSTS (\$1000)	RESURFACING (\$1000)	ANNUAL (\$1000)	H.O.M. (\$1000)	RESURFACING (\$1000)	CONSTRUCTION (\$1000)	TOTAL COSTS (\$1000)	DAILY VOLUME
1971	1445.	0.	9.	0.	0.	0.	1454.	13400.
1972	1445.	0.	9.	0.	0.	0.	1454.	14925.
1973	1805.	0.	10.	0.	0.	0.	1815.	16142.
1974	2020.	0.	11.	0.	0.	0.	2031.	17459.
1975	2261.	0.	11.	0.	0.	0.	2273.	18882.
1976	2533.	45.	12.	0.	0.	0.	2580.	20422.
1977	2130.	0.	7.	0.	0.	0.	2136.	22087.
1978	2378.	0.	8.	0.	0.	0.	2385.	23888.
1979	2645.	0.	8.	0.	0.	0.	2653.	25837.
1980	3229.	0.	9.	0.	0.	0.	3239.	27943.
1981	3630.	0.	11.	0.	0.	0.	3641.	30222.
1982	4072.	0.	12.	0.	0.	0.	4084.	32035.
1983	4573.	35.	13.	0.	0.	0.	4595.	33957.
1984	4515.	0.	8.	0.	0.	0.	4620.	35995.
1985	5037.	0.	9.	0.	0.	0.	4523.	38154.
1986	5632.	0.	11.	0.	0.	0.	5046.	40444.
1987	6358.	0.	12.	0.	0.	0.	5642.	42870.
1988	7193.	0.	14.	0.	0.	0.	6366.	45442.
1989	8196.	35.	16.	0.	0.	0.	7207.	48169.
1990	8640.	0.	10.	0.	0.	0.	8247.	51059.
1991	10302.	0.	11.	0.	0.	0.	8650.	54122.
1992							10314.	57370.
SALVAGE VALUE							23.	

TOTAL LESS SALVAGE VALUE 90255.

PRESENT VALUES DISCOUNTED AT 11% 27073.

OUTPUT 12. SECTION 12 - No IMPROVEMENTS

* RECOMMENDED *

* LINK ANALYSIS - SECTION 12 *

ALTA VISTA DR FROM SMYTH RD TO INDUSTRIAL AVE

ALTERNATIVE NO. 1: NORMAL AND DIVERTED TRAFFIC

COMPLETE RECONSTRUCTION TO DESIGN STANDARD

CAPITAL COST (\$1000) 150.

SERVICE LIFE CONSTRUCTION 20 YEARS

RATE OF RETURN
BENEFIT/COST = 115.02
NET BENEFITS (\$1000) = 705.8

Raised to Maximum
SURFACE CONDITION ADEQUACY
10 20

No Change
SPLIT ZONE SURFACE TYPE
(N.P.N.) 30.

TRAFFIC SIGNALS 1.

CURVATURE (DEGREES) 133.

STRUCTURAL ADEQUACY 20

Conditions

When

Rehabilitated

TRAFFIC DATA

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

CLASS 4000

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Section 12

1. DATA

2. RESURFACING

3. SPLIT

4. SPLIT

5. SPLIT

6. SPLIT

7. SPLIT

8. SPLIT

9. SPLIT

10. SPLIT

11. SPLIT

12. SPLIT

13. SPLIT

14. SPLIT

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33. SPLIT

34. SPLIT

35. SPLIT

36. SPLIT

37. SPLIT

38. SPLIT

39. SPLIT

40. SPLIT

Periodic Maintenance Costs

Normal

Rehabilitation

Capital Costs

Resurfacing

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

Construction

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Construction

Year

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1979

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1981

1982

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1984

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1986

1987

1988

1989

1990

1991

1992

1993

1994

1995

1996

1997

cf. with 27,195 if

not rehabilitated

OUTPUT 13. SECTION 12 - REHABILITATED

 * HIGHWAY COST MODEL DATA *
 *

DESCRIPTION	VEHICLE PARAMETERS	CODE	VALUES			
			TRUCKS			
			LIGHT	MEDIUM	HEAVY	BUSES
1. VEHICLE WEIGHT (LBS.)						
2. PAYLOAD (LBS.)			3500.	5750.	24000.	20100.
3. LOAD FACTOR (ACTUAL/CAPACITY)			900.	7750.	33200.	19000.
4. HORSEPOWER (SAF)			0.33	0.50	0.81	0.18
5. TIRE WEAR PARAMETER			187.	165.	210.	172.
6. TIRE COST (PER TIRE)			0.00029	0.00035	0.00061	0.00039
7. FUEL COST (PER GALLON)			46.5	84.0	154.0	143.5
8. LIFETIME MILEAGE (1000'S)			0.333	0.333	0.333	0.185
9. AVERAGE OPERATING SPEED			110.	150.	400.	500.
10. INTEREST RATE (%)			11.	11.	11.	11.
11. AVERAGE ANNUAL MILEAGE (1000'S)			9.	14.	58.	45.
12. VEHICLE COST (WITHOUT TIRES)			3620.	5770.	15100.	38450.
13. OIL COST (PER QUART)			0.9	0.9	0.9	0.9
14. OIL CONSUMPTION (PER 1000 MILES)			2.1	2.5	3.7	3.0
15. NUMBER IN CREW			1.34	1.22	1.22	20.37
16. AVERAGE CREW WAGE (PER HOUR)			1.5	5.1	3.8	1.7
17. PARTS COST FRACTION (PER MILLION MILES)			0.0000016	0.0000044	0.0000019	0.0000011
18. LABOUR NEEDS (HOURS PER MILE)			0.00095	0.00116	0.00350	0.01750
19. MECHANICS WAGE (PER HOUR)			5.1	6.0	6.0	6.0
20. CURVATURE CONSTANT			0.0008	0.0008	0.0008	0.0008
21. EQUIVALENT VEHICLES			1.0	2.5	1.4	6.2
22. EQUIVALENT AUTOS			1.0	2.5	3.0	1.8
23. FIXED COSTS (PER YEAR)			227.	435.	1506.	2331.

 * HIGHWAY MAINTENANCE DATA *

A. SERVICE LIVES (YEARS)		STRUCTURAL ADEQUACY		CODE		ASPHALT ON CONCRETE	CONCRETE	HIGH CLASS BIT	INT. CLASS BIT	LOW CLASS BIT	GRAVEL
1. GOOD (15-20)		SURLIF				30.	25.	20.	16.	10.	3.
2. FAIR (8-14)		SURLIF				15.	12.	10.	10.	6.	2.
3. POOR (0-7)		SURLIF				6.	6.	6.	6.	4.	1.
B. EFFECTIVE ROAD SURFACE AGE											
1. CONSTANT FOR AGING (AGE)						0.75	0.75	0.75	0.50	0.25	0.25
2. CONSTANT FOR VEHICLE LOADING (VLS)						0.0000670	0.0000670	0.0000670	0.0002011	0.0006034	0.0030242
C. ANNUAL MAINTENANCE COSTS (PER MILE)											
1. ROADSIDE <i>Not Applicable in Tropics</i>						1050.	1050.	1050.	1050.	1050.	590.
2. WIDENING						1690.	1690.	1690.	1690.	1690.	850.
3. BRIDGE AND CULVERTS						235.	235.	235.	235.	235.	100.
4. SAFETY CONTROL						460.	460.	460.	460.	460.	210.
5. CONSTANT FOR ROAD WIDTH (CRM)						410.	410.	410.	410.	410.	245.
6. CONSTANT FOR ANNUAL TRAFFIC (CAT)						0.094	0.094	0.094	0.094	0.094	0.719
D. PERIODIC MAINTENANCE COSTS (PER LANE MILES)											
1. COMPLETE RESURFACING						9600.	9600.	9600.	9600.	9600.	3560.

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